The Southern Surgeon

Subscription in the United States, $5.00

Vol. XIII, No. 6

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The Southern Surgeon Publishing Co.
JUNE, 1947

SURGICAL ASPECTS OF THROMBOCYTOPENIC PURPURA

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INTRODUCTION

IN the case of thrombocytopenic purpura the surgeon is called as a consultant practically always for one reason: to determine the advisability of relieving this condition by splenectomy. Everyone is familiar with the essential clinical facts of the disease, that the etiology is unknown, and that it occurs most frequently in children and young people, more often in young women. It is characterized by the abrupt appearance of petechiae and ecchymoses, chiefly over the extensor surfaces of the limbs, but sometimes over the entire body. It is accompanied by bleeding from all the mucous membranes, and this is unaffected by local applications. In thrombocytopenic purpura the blood platelets are markedly diminished or entirely absent. Patients have a prolonged bleeding time but a normal, or only slightly prolonged, clotting time, with a failure of the clot to retract. The tourniquet test is positive.

The surgical consultant must, however, be sure of the accuracy of the diagnosis. Naturally, knowing by exclusion that the other platelet-depressing conditions must be ruled out, he is concerned with the history, including a careful history of acute and chronic infections, drug therapy, history of the patient's occupation, particularly in industrial areas where solvents are used. He realizes that he is probably seeing only 1 out of 3 of these cases, as the

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From the Cleveland Clinic, Cleveland, Ohio.

Read before the fifteenth annual Postgraduate Surgical Assembly of the Southeastern Surgical Congress, Louisville, Ky., March 10-12, 1947.

others either have had spontaneous remission or have responded to repeated blood transfusions or parathormone. My associate, Dr. Haden,[1] who has had a large experience with this disease, has used parathormone almost to the exclusion of any other drug therapy. This was first established following an observation by Lowenburg and Ginsberg[2] in 1932 when after a heavy dose of parathormone the blood calcium reached 19.6 Gm. per 100 c.c., with the development of urticaria but with immediate clearing of the purpuric manifestations. The mechanism of this therapy has not been adequately explained.

In the selection of cases for splenectomy it is essential that a study of the bone marrow be made in every instance to rule out aplastic anemia, leukemia, myelomatosis, leukopenic leukemia, and pernicious anemia, with secondary thrombocytopenia. Doan and Wiseman[3] say that most observers have found the bone marrow to be normal, a pertinent statement that coincides with our experience. They also feel that any abnormality observed in the marrow is merely a reflection of blood loss and that the megakaryocytes failed to demonstrate qualitative or quantitative alteration. Dr. Haden has repeatedly pointed out that, from a physical standpoint, if the spleen is enlarged one is not dealing with essential thrombocytopenic purpura.

There is no constant pathologic picture in spleens removed at operation or examined postmortem. They are practically always normal in size. If they are enlarged one should suspect secondary thrombocytopenic purpura. Likewise, the gross examination adds little to our knowledge about the disease. A typical report of such an examination will be that the spleen is normal in size and weight, covered by a thin capsule, light grayish-brown in color, and normal in consistency. The cut surface is dark red with a grayish mottling. There are no fibrosis, infarctions, or distinctive gross lesions. The lymphoid follicles are numerous and small. A typical microscopic examination shows that there is slight generalized hyperplasia of the pulp and lymphoid tissue with little or no fibrosis and no unusual pigmentation or abnormal cell types.

Operative Technic

Wilkie[4] states that in textbooks of operative surgery no operation is described so inadequately as splenectomy. He, however, gave a very accurate description of the technic which he follows. Unquestionably, this operation lends itself to standardization, but frequently it is done as an emergency operation, in which the patient has active bleeding at the time. However, when a splenectomy is

performed, for whatever indication, a thorough knowledge of the surgical anatomy involved and the development of a technic based on this anatomy will help to facilitate the procedure. This involves an accurate knowledge of the peritoneal folds which go to make up the ligaments of the spleen and the accompanying blood vessels.

The spleen is a soft, elastic, slightly contractile organ situated in the upper left posterior part of the abdomen, partially in the epigastrium but mainly in the left hypochondrium. It measures approximately 4½ inches by 2½ inches by 1½ inches and weighs about 150 Gm. In the recumbent posture the long axis corresponds with the direction of the posterior part of the tenth rib.

The spleen is entirely covered by peritoneum except in the region of the hilum and is moored by two constant peritoneal folds, the lienorenal and gastrosplenic folds. Inferiorly it is supported by the peritoneal phrenicocolic ligament which is at times incorrectly named as a ligament of the spleen. There may be either adhesions or a peritoneal band binding it to the diaphragm.

Dunphy[5] has pointed out that actually the splenic pedicle is composed of three separate layers, (1) the presplenic fold which extends from the great omentum to the lower pole of the spleen, (2) the gastrosplenic ligament described above, and (3) the lienorenal ligament which is a double fold of peritoneum containing the splenic artery and vein and the tail of the pancreas.

The vessels of the spleen are the splenic artery, a branch of the celiac which runs across the superior border of the pancreas and enters the spleen through the layers of the lienorenal ligament, at the hilum breaking up into six or more branches which enter independently. The splenic vein is formed within the lienorenal ligament by union of several branches which emerge from the hilum. The lymph vessels are also located at the hilum. They drain only the capsule and trabecules, since the splenic substance is devoid of lymphatics. They open into lienal lymph glands near the hilum. The nerves come from the celiac plexus and accompany the vessels.

Curtis and Movitz[6] have reported a surprisingly high percentage of accessory spleens. In a series of 174 cases they found that 56 patients had accessory spleens and that in primary thrombocytopenic purpura the incidence was 44 per cent in the first decade and 33.3 per cent in the second decade. In the 56 patients, the 131 accessory spleens found were located as follows: hilar region, 54.2 per cent; pedicle, 25.1 per cent; omentum, 12.2 per cent; retroperitoneum, 6.1 per cent; splenocolic ligament, 1.5 per cent, and bowel mesentery, 0.75 per cent. In 85.7 per cent they were found in but

a single location, but in no case were they found in more than two locations; in all instances in which they occurred in two locations the hilus was one.

In splenectomy the anesthetic of choice is inhalation anesthesia. Of the various agents used, I prefer nitrous oxide and ether. Any type of instrumentation for anesthesia in the nasopharynx, upper respiratory tract, or trachea is contraindicated. While it is true that a dilated stomach may be troublesome in splenectomy, this has not been a technical problem in this series of cases. For the same reason that intratracheal instrumentation is contraindicated, it is felt that insertion of a Levine tube may be the source of mucous bleeding.

A splenectomy may be performed through any one of several incisions. I have used most a left paramedial incision, which usually has to be augmented by a transverse incision extending well laterally. However, I prefer to use a subcostal incision and, as Binnie[7] long ago pointed out, it should be carried to a point opposite the end of the 11th rib. This incision can be extended if the exposure is not adequate. Some authorities have recommended a transrectus incision. In no operation is an adequate exposure more desirable than in this procedure, and the incision should be made so that all the steps are carried out completely under direct vision and with as little retraction as possible. The subcostal incision is an oblique one begun in the midepigastrium and is extended laterally and downward to just above the crest of the ilium. The anterior rectus sheath is incised, and the external oblique fascia and muscles are cut, allowing the rectus muscle to be retracted medially. The incision passes between the internal oblique fibers, and the transverse muscle is cut in the same line. In many of these patients the bleeding and oozing from the cut surface may be extremely troublesome, but this may be lessened by keeping the incision in one plane. For this reason, after exposing the fascia at a point about midway in the incision, I have cut through the fascia and, after separating the muscles, have picked up the peritoneum and incised, together with the coverings over it, enough to allow the fingers to enter the abdominal cavity. The incision is then carried downward and a similar one made toward the epigastrium for the full length of the incision. If the dissection is carried directly through the various layers of muscles, the tendency is to cut through several different planes, resulting in gross bleeding which may be lessened by following the above technic. Upon opening the abdomen all but a small portion of the spleen is seen to be covered by the stomach. The spleen is palpated to determine its size, consistency, and the possible pres-

ence of adhesions which restrict its mobility. The adhesions of the spleen to the diaphragm may be freed by blunt dissection without encountering troublesome bleeding.

It is extremely important in handling the spleen that no fracture of the capsule take place lest troublesome bleeding occur before the spleen is mobilized. Balfour[8] has advised that as soon as the spleen can be dislocated forward it is advantageous to place a pack in the fossa posterior to the spleen. This will control any troublesome oozing on the posterior peritoneal surface and from the filmy adhesions which may be present between the spleen and the diaphragm. The first step in the actual removal of the spleen is the division of the gastrosplenic omentum and the careful ligation of the vasa brevia. It is very easy to place a clamp across the wall of the stomach during this step, and it is advisable to cut these short gastric vessels as close to the spleen as feasible. In some cases it may be easier actually to divide the pedicle first and to divide the gastrosplenic omentum as a second step. In still other instances the mobilization of the spleen may be facilitated by dividing the posterior layer of the lienorenal ligament and freeing the lower pole. The hand can then be placed over the phrenic surface of the spleen and, by retracting to the right, the spleen can often be delivered to the level of the abdominal wall. If the lienorenal ligament has not been divided it can be plainly visualized and ligated. The posterior layer of this ligament is often completely avascular, but on one occasion a vessel was present of such size that a marked hemorrhage occurred. Any adhesions to the colon can be clamped at this time.

It affords a sense of relief when the spleen is mobilized and the pedicle can be grasped between the thumb and the first finger on the left hand. Then the vessels can be dissected out and ligated separately or en masse, the pedicle being divided between Kelly clamps.

I have not used the procedure advocated by Singleton[9] in which he ligates the splenic artery close to its origin. It is preferable to transfix the sutures. The clamps should be placed as close to the spleen as possible, care being taken to avoid injuring the tail of the pancreas. Troublesome bleeding may result from such an injury and a large raw surface of the pancreas may be exposed. While these procedures are being carried out practically all oozing from the raw surfaces beneath the diaphragm will have stopped, and when the large pack is removed the area will usually be dry.

After the spleen has been removed it is important again to in-

spect the pedicle to make sure that there is no oozing and also to make certain that no accessory spleens are left behind.

Closure is made with a figure of eight suture of No. 36 cotton thread, and includes the fascia, muscles, peritoneum, and then back through the fascia. The skin is closed with clips.

These patients often have a very low hemoglobin, and it is essential that transfusions be used both before and during the operation. Every surgeon is aware that clamping of the pedicle results in a marked change in the oozing from all raw surfaces.

	Number of Cases	Percentage
Splenectomies at Cleveland Clinic	28	
Cures without recurrence	16	57.2%
Recurrences	9	32.1%
Improvement with slight rec.	6-21.4%	
Improvement with severe rec. (requiring transfusions or parathormone)	2-7.2 %	
Death during recurrence	1-3.5 %	
Postoperative deaths	3	10.7%
Cures and Improvement with slight recurrence	22	78.6%

In this series of 28 cases the average age was 26 years and 8 months, the youngest patient being 20 months and the oldest 61 years. There were 3 postoperative deaths, a mortality of 10.7 per cent. Sixteen patients (57.2 per cent) have been considered cures without recurrence. There have been 9 recurrences (32.1 per cent); 6 of these (21.4 per cent) were considered markedly improved with slight recurrence; 2 (7.2 per cent) showed improvement after severe recurrence requiring transfusions or parathormone; 1 patient died after a recurrence a year and a half following splenectomy. There have been, therefore, 22 patients (78.6 per cent) cured or improved with slight recurrence. In other words, a good result has been obtained in 70 per cent of these cases. Interestingly enough, of 6 patients with thrombocytopenic purpura on whom splenectomy was advised but not performed, 4 died of the disease.

Postoperatively, the surgeon is concerned about whether or not bleeding stops. For a long time I felt that unless there was a marked platelet response the prognosis was not good. Now I know that this is not true and that if the patient looks and feels well and has stopped bleeding, these signs are more important than the platelet count. Diggs,[10] in a survey of these cases, found that, after a 3 to 5 year period, in some of these patients the platelets would never increase. However, these patients had no recurrences and their clinical status was satisfactory. On the other hand, many of the patients

who had very high platelet counts would eventually end with a platelet count only slightly above the group who had no platelet response. Interestingly enough, in analyzing 6 of these patients who had recurrences after splenectomy, it was found that the platelet counts in this group all fell in an intermediate group, the counts being somewhere around 400,000, but never reaching a high point. For this reason, therefore, I believe that the general well-being of the patient is far more important than the platelet counts. The charts of these patients would frequently indicate that they might be acutely ill. The charts might even resemble those of patients with a hyperthyroidism reaction. This is particularly true in children when the pulse rate is very high and accompanied by a corresponding rise in the temperature. I have always felt that this might be an absorption from the serum which may be within the peritoneal cavity. The one symptom, either before or after operation, with which I am always concerned is the intractable headache, which is often a premonitory symptom of a cerebral hemorrhage, the most common cause of death in these patients.

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THE USE OF ATMOSPHERIC PRESSURE IN OBLITERATING AXILLARY DEAD SPACE FOLLOWING RADICAL MASTECTOMY

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PRIOR to the close of the last century the treatment of cancer of the breast was extremely unsatisfactory. With the publishing of papers by Halsted[1] and Meyer,[3] in 1894, radical mastectomy became the treatment of choice for this condition. Although the results obtained in the treatment of carcinoma of the breast improved, this therapy left much to be desired. The introduction of radiation into the armamentarium of the clinician interested in this problem was, therefore, a welcome adjunct. The high hopes held for irradiation in mammary carcinoma fifteen or more years ago have not been realized, and this disease is again looked upon as primarily a surgical problem.

The technic of radical mastectomy as performed today varies little from that described by Halsted[1] in 1894. The principle upon which this operation is based is the removal of the local lesion, adjacent lymphatic channels and nodes to which early metastases are likely to occur, before spread beyond these structures has occurred. The breast is particularly well suited to this type of therapy. The removal of the breast with a large amount of skin surrounding the tumor, the subcutaneous tissue, both pectoral muscles and axillary contents in one mass, as advocated by Halsted[1] half a century ago, has yielded the best results in cancer of the mammary gland. A review of the literature leaves the impression that the results obtained in the treatment of carcinoma of the breast have improved recently. This is due to a great extent to more critical selection of patients for curative therapy, making the criteria of operability more limited.

The operation of mastectomy combined with axillary dissection is a major surgical procedure, and as such carries a definite risk to life. In addition, there are other undesirable features and complications that must be borne in mind. The cosmetic effect of the loss of the breast is a minor problem with the development and wide availability of suitable prosthesis. Cicatricial limitation of the arm and postoperative edema of the upper extremity are complications that have been recognized since this operation's inception. These are sequelae of greater magnitude.

Read before the fifteenth annual Postgraduate Surgical Assembly of The Southeastern Surgical Congress, Louisville, Ky., March 10-12, 1947.

The limited function of the arm is due to contracture of scar tissue and is more likely to occur when the scar extends across the axilla onto the arm, or when failure to obtain primary healing leads to excessive formation of fibrous tissue. Edema not due to recurrent disease is ascribed to a variety of conditions. Those most widely accepted as etiologic factors are: (1) postoperative inflammation with fibrosis, in line with Halsted's theory;[2] (2) venous obstruction, regarded by Veal[4,5] as the important factor; (3) lymphatic block, on which Devenish and Jessop[6] believe the edema is entirely dependent; and (4) tenting of the lateral flap across the axilla leaving a dead space with subsequent fibrosis, the major cause in the opinion of Rienhoff.[7]

Even though unanimity of opinion regarding the etiology of the edema is lacking, this complication undoubtedly occurs less frequently and the function of the arm is improved following radical mastectomy if primary healing is obtained. To accomplish this result, meticulous surgical technic is a necessity. The prophylactic use of chemotherapy should limit inflammation and subsequent fibrosis and thereby aid in preventing these complications. Many surgeons employ and stress the use of packs in the axilla to obliterate the dead space and thus limit fibrosis. Reinhoff[7] advocated the transplantation of a portion of the latissimus dorsi muscle to obliterate axillary dead space and to act as a bridge for new lymphatics to form between the arm and the wall of the chest. Early mobilization of the arm is believed by most surgeons to aid in preventing limited motion in the upper extremity after radical mastectomy.

It is impossible to close the wound following radical mastectomy without trapping air beneath the flaps. If this entrapped air is removed by aspiration following air-tight closure of the skin, the skin flaps are sucked or pressed into contact with the underlying tissue by atmospheric pressure. This apposition will be maintained unless the vacuum is broken by an accumulation of fluid. The following method, utilizing the atmospheric pressure to obliterate the axillary dead space following radical mastectomy, has been found useful.

Before closure of the wound, instead of the customary drain, a large (24 F) catheter containing multiple perforations is passed through a small stab wound so that the skin fits snugly about the catheter, just anterior to the latissimus dorsi muscle, and its tip is placed in the apex of the axilla but not in contact with the vessels or nerves (fig. 1). The skin is then closed. A syringe of 50 or 100 c.c. capacity is attached to the catheter, and the air is withdrawn from the axilla. The skin flaps are immediately sucked into

the axilla and are then arranged so that they fit smoothly into the axillary dead space. The catheter is tied, and a dressing is applied, leaving the arm free. The end of the catheter is not covered by the main dressing. Thereafter the catheter is aspirated every twelve hours. Between aspirations the catheter is tied to prevent

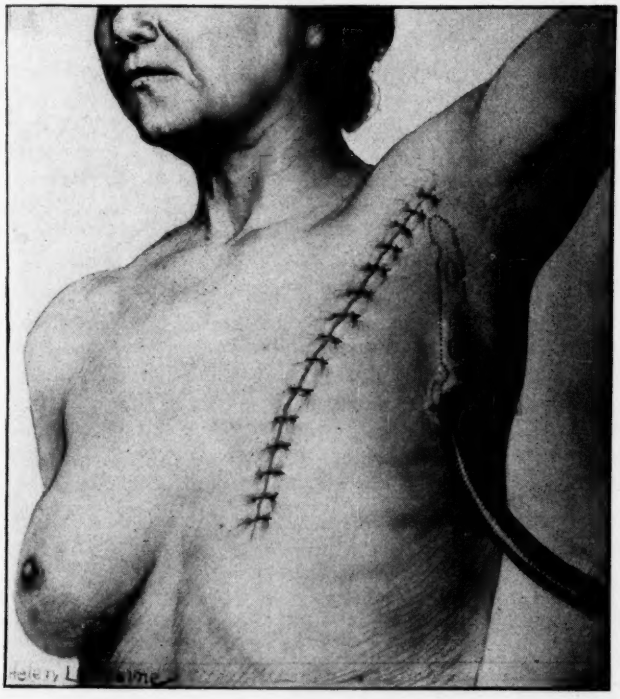

Fig. 1. This drawing illustrates the position of a large catheter (24 F), containing multiple perforations, which has been placed through a snugly fitting stab wound anterior to the latissimus dorsi muscle so that the tip lies within the apex of the axilla. Care is taken to avoid letting the catheter contact the axillary vessels or nerves. A syringe is attached to the catheter every twelve hours for aspiration of entrapped air or fluid. Between aspirations the end of the catheter is tied.

the entry of air into the wound with elevation of the flaps. Continuous suction of the Wangensteen type would seem ideal and was first used, but was abandoned because of a tendency for tissue to enter the perforations and obstruct the catheter when suction was maintained. The catheter is removed when no fluid forms for 24 hours.

This method of handling the axillary dead space has been used

successfully in 25 cases. The following advantages have been noted:

(1) Early and complete obliteration of the axillary dead space with minimal fibrosis is accomplished. The skin and chest wall remain in contact throughout the healing period.

(2) There is free use of the arm immediately following the operation as a pressure dressing is not necessary.

(3) Infrequent dressings are required; it is usually unnecessary to change the dressing until the sutures are removed. There is no drainage.

SUMMARY

Mastectomy in the treatment of cancer of the breast is briefly reviewed, and the sequelae that may result when this operation is combined with axillary dissection are discussed.

A method of obliterating axillary dead space following radical mastectomy by the use of atmospheric pressure is described, and its advantages are explained.

A series of 25 cases is reported in which this procedure was successfully employed.

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THE PRESENT STATUS OF SURGICAL TREATMENT OF CARCINOMA OF THE LUNG

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THIRTEEN years have now elapsed since the first total pneumonectomy was performed in the Johns Hopkins Hospital. Previous to that time a diagnosis of pulmonary malignancy was made infrequently and more for academic than for practical reasons. Prior to this time no therapeutic measures or methods were available which offered the patient more than palliation. Medicinal and radiation therapy were then, as now, equally ineffective and the disease when so treated was, and is, always fatal.

The surgical treatment of malignant tumors of the lung has been a boon to patients and a lively stimulus to clinicians interested in pulmonary lesions. Because of this increased interest on the part of physicians the diagnosis of tumors of the lung is made much more frequently than in the past with the result that a greater number of such patients are being referred for operation. In a medical center in which a special interest in this type of surgery has been manifested, what seems a disproportionate increase in the frequency of these cases is apt to occur, but it may probably be true that the incidence of primary pulmonary cancer is on the increase.

It is the purpose of this report to record the clinical analysis, preoperative preparation, operative procedure, immediate and remote postoperative results in a series of 327 consecutive cases of carcinoma of the lung which have been referred for surgical treatment, not accounting for those instances in which the patient was obviously inoperable from the standpoint of the clinical findings.

CLINICAL ANALYSIS

Etiology. Although the etiologic factors involved in the production of cancer are unknown, there is enough data accumulated to draw some conclusion as to the influence of certain factors to which human beings are exposed. In this and other series of cases reported one fact has been outstanding as probably playing a definite role in the production of pulmonary carcinoma, that is that the great majority of patients afflicted with this malady are residents of urban districts. In such districts, from the cradle to the grave, the lungs

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Read before the fifteenth annual Postgraduate Surgical Assembly of The Southeastern Surgical Congress, Louisville, Ky., March 10-12, 1947.

are constantly exposed to many irritating substances, such as dust, dirt, various fumes, gases and other atmospheric pollutions which have a deleterious effect on the lining cells of the bronchial tree throughout its entire extent. It is a well known fact that miners and particularly in various places in the world laborers, exposed to certain foreign particles in the air, are very prone to develop growths in the lung. It is also fully recognized that individuals who are working in contact with irritating gases, such as chlorine and others, frequently develop epithelial growths in the air passages. Changes in oxygen tension will affect the type of epithelial lining cells, often causing a metaplasia from the cylindrical cell to a flat cell. This morphologic transposition may also be found in the bronchi which are tributaries to areas of infection such as lung abscess or bronchiectasis. In other words, chronic irritation, regardless of the type, will produce changes in the growth rate and shape of the cells of the lung which seems to be very sensitive to this pollution of the atmosphere. It will be interesting, now that women are smoking, to see if the much higher ratio of the malignancy of the lung in men is decreased by an increase of the incidence in women.

Table 1.—Distribution According to Sex of Cases of Primary Carcinoma of the Lung

	Operable	Inoperable
Male	84%	86%
Female	16%	14%

Due to the occupational hazards mentioned above, as well as habits, a higher incidence of primary malignant tumors of the lung is to be expected in the male than in the female. Table 1 shows the distribution according to sex of the patients in this series. It is to be noted that there is a much higher incidence in the male than in the female, a ratio of almost 6 to 1 in favor of the males. The incidence of involvement of the right and left sides is approximately the same.

In regard to the age incidence of primary malignant tumors of the lung, this does not vary to any great extent from the age incidence of malignant growths elsewhere in the body. The majority of the patients were in the fourth to sixth decades. Perhaps patients in the second to fourth decades were more frequently affected than would be the case of other viscera; however, this series of cases, although relatively large, is far too small to warrant an exact statement. Twelve of the cases fall into the sixth decade. The oldest patient in this series to be operated on was 76 years of age and the

youngest 19. Age, in itself, seems to offer no contraindication to operation. Not infrequently an older patient from a physiologic point of view is a far better operative risk than a younger one. In this series the older patients were surprisingly unaffected by the operative procedure, including the patient aged 76, and generally had uneventful postoperative convalescences. Pulmonary cancer, however, generally speaking is a disease of advanced age.

Unfortunately for the lay public, physicians as a whole, because of the lack of therapeutic measures to combat such lesions or to treat them effectively, have been less acutely interested in the possibility of malignant growths of the lung than those of other viscera or organs of the body. It is therefore important that not only all physicians, but also the lay public, should become cognizant of their respiratory tracts in order that they may at the earliest moment seek confirmation or dissipation of their apprehensions in regard to signs and symptoms originating in their respiratory organs.

It is mandatory that knowledge of the signs and symptoms originating as a result of malignant tumors of the lung be made known to the public as a whole just as every woman knows the significance of a tumor of the breast and realizes the importance of immediately consulting a physician concerning such a tumor.

In the analysis of the series of patients herein reported, in regard to the most frequent signs and symptoms occurring in such cases of primary cancer of the lung, only those signs and symptoms were included that could be attributed to involvement of the lung itself and not to invasion of contiguous structures or distant metastases. In 71 per cent of the patients in this series cough was the chief symptom. In a nation of heavy cigarette smokers, in which the population supplying the majority of patients breathes the polluted atmosphere of cities, cough is almost universal and is due mainly to nonspecific irritation of the respiratory tract. The important point about coughing that should make one suspicious of the presence of an intrabronchial growth is the departure from the normal for any individual. If in an adult "chronic cougher" the type of cough changes to spasmodic, productive or nocturnal type, or again, if a person who has heretofore coughed infrequently suddenly begins to be annoyed by a hacking cough day and night, attention should be focused on the bronchial tree and the presence of a bronchial neoplasm should be suspected. The development of a cough or changes in the character of coughing can portend an extremely serious condition. Until physicians as a whole, as well as the lay public, become more acutely aware of the serious significance of this sign, the opportunity for early and satisfactory treatment of

pulmonary neoplasms will be denied to many patients. It is to be noted again that the outcome in this condition, unless recourse is had to surgery, is invariably fatal. These symptoms and signs are listed according to the frequency of their occurrence in Table 2.

Table 2.—SIGNS AND SYMPTOMS OF CARCINOMA OF THE LUNG

Cough	71%
Hemoptysis	63%
Pain	50%
Loss of weight	39%
Hyperpnea	23%
Pneumonitis	18%
Fever	13%
Tightness in chest	3%

In 63 per cent of our patients expectoration of blood or hemoptysis was associated with coughing. This varied from streaking of the sputum to the expectoration of large and copious amounts of blood, up to 6 ounces (180 c.c.). In the latter group the accumulation of blood in the mouth was preceded by a "gurgling" in the chest on one side which warned the patient of the impending hemoptysis. In our experience copious hemoptysis has usually been associated with the adenocarcinoma type of intrabronchial growth. Unless the x-ray and sputum examination are indisputably those of tuberculosis or bronchiectasis, hemoptysis must be considered to be due to an intrabronchial growth until this has been ruled out by the many types of examinations at our command. The burden of proof is on the physician who in any given case states that hemoptysis is not due to a tumor of the lung. This is true even though a small number of tubercle bacilli may be present in the sputum. Tuberculosis and cancer may be associated and were in four cases in our series. Clinical examinations to diagnose an intrabronchial tumor in no way interfere with the treatment of pulmonary tuberculosis; but if a patient bleeding from a tumor of the lung is observed for months in an attempt to prove the case to be tuberculosis, in many instances he will have lost his only opportunity for successful treatment. The discovery that the bleeding was originally from a neoplasm will have come too late.

Although it is uncommon to have pain as a prominent symptom in cancer of other organs, it is third in prominence among the signs and symptoms in patients afflicted with cancer of the lung. Pain arising from an intrabronchial neoplasm must be differentiated from the pain due to direct invasion of contiguous structures. Pain arising from the lung itself is not associated with the respiratory cycle, as is the pain of pleuritis. It is most often described by the patient as a constant dull ache deep in the chest. The frequency with which

the actual position of the tumor, as shown by roentgenography, coincided with the location of the level of pain on the chest wall as indicated by the patient was surprising. In all probability pain does not arise within the tumor itself but is a result of pressure on the bronchial wall. Persistent pain in the chest, in the absence of inflammatory disease or aspiration of a foreign body, should always lead to careful investigation of the respiratory tract. Pain down the arm or in the chest wall, so characteristically found in the so-called "superior sulcus or Pancoast tumor," is as a rule due to direct invasion of the ribs or the brachial plexus or both. This distribution of pain is considered a very unfavorable symptom from the standpoint of operability.

Loss of weight due to cachexia in advanced carcinoma of any organ in the body, particularly the gastrointestinal tract, is well known and obvious; but not so easily understood was a striking loss of weight in 39 per cent of the cases of pulmonary carcinoma. This loss of weight was, of course, due in part to coughing, loss of appetite because of hemoptysis and sputum, worry and so on; but the rapid gain of 30 to 50 pounds in a few months after total pneumonectomy for the removal of a relatively small growth remains unexplained.

Fifth on the list of signs and symptoms is hyperpnea, occurring in 23 per cent of the patients. These patients complained of a sudden desire to breathe in deeper breaths, not exactly similar to air hunger but approximating this condition. The deep breathing sensation one experiences when breathing carbon dioxide would seem to be similar. This paroxysmal hyperpnea came on suddenly and lasted for a few seconds or a few hours. The mechanism for this respiratory phenomenon is difficult to explain. It may possibly be caused by a plug of mucus occluding a secondary or tertiary bronchus already partly plugged by an intrabronchial neoplasm, the bronchopulmonary segment of lung, to which the occluded bronchus is a tributary, thus becoming the site of an obstructive emphysema. Reflex disturbances in the respiratory rate and amplitude are thus set up. With expulsion of the mucus plug the respiratory rate returns to normal. Such unusual changes in the respiratory cycle, even though of short duration, should excite one's curiosity sufficiently to suggest a thorough examination of the bronchial tree.

Eighteen per cent of the patients had suffered from attacks of pneumonitis associated with bouts of fever and all the signs and symptoms characteristic of pneumonia. It was frequently possible to obtain a history of numerous attacks of so-called "pneumonia" in the recent past. The chief characteristic of these attacks was that

they occurred at any time of the year with apparently no tendency toward seasonal incidence, as in the true epidemic pneumonia. Furthermore, physical signs were atypical and in unusual locations as regards the lung itself. Lobar, broncho or interstitial pneumonia, as a rule, present fairly typical physical signs. This is not the case in pneumonitis due to bronchial obstruction associated with primary carcinoma of the lung. The explanation for these unusual observations is not far to seek when their pathogenesis is considered. When obstruction of a bronchus, whether primary, secondary, tertiary, or quaternary, occurs as a result of a new growth alone or in association with mucus plug, the bronchial tree peripheral to the point of occlusion becomes filled with mucus. Eventually infection of this bronchopulmonary segment occurs and the clinical syndrome of localized pneumonitis is produced. A portion of a lobe of greater or lesser dimensions, the entire lobe, or even the entire lung, may be involved. If exacerbations of such a pneumonitis are of sufficient frequency, bronchiectasis or even an abscess will at times supervene. Often such an abscess perforates into the pleura and produces putrefaction empyema. The point to be emphasized is that when such an unusual sequence of events takes place, or when any one of the aforementioned inflammatory episodes occurs that cannot be explained as a complication of a typical pneumonia, or as a result of aspiration of a foreign body, an intrabronchial growth should be suspected. It is the repetitious nature of such pneumonitis which makes it so significant.

In general, it may be stated that there are no characteristic or pathognomonic signs and symptoms of primary carcinoma of the lung. This lesion masquerades as many of the commoner disorders of the lung. The onset is often insidious, but the recurrent nature of signs and symptoms previously described should call attention of patient and physician to the respiratory tract so that a thorough examination will be carried out. Especially is this true of a patient who has previously had excellent health and in whom after the second decade there develops a cough associated with spitting of blood. Too often precious time is lost because of a diagnosis of pulmonary tuberculosis, lung abscess, unresolved pneumonia, bronchiectasis or heart disease. The methods of examination employed to rule out the presence of an intrabronchial growth in no way interfere with the diagnosis or treatment of any of the conditions which are at times mistaken for such a growth.

Diagnosis

In this series of 327 cases the roentgenograms of the chest were positive in every instance. It is not suggested that a diagnosis of

primary carcinoma of the lung could be made from the roentgenographic studies alone, but there was in each case an abnormal shadow which necessitated further study and examination. Thus it may be stated emphatically that in every instance in which roentgenograms of the chest show a departure from normal, and in which this departure is not in every way characteristic of one of the commoner lesions of the lung, the presence of bronchogenic cancer should be inferred. Unquestionably, the x-ray of the chest is the most important and simplest method of examination at our disposal. Even in the earliest stages of growth of a primary carcinoma of the lung the lesion, as a rule, can be discovered. In the early part of the last decade and even today it was and is disheartening to watch an early lesion develop over a period of months into an inoperable cancer of the lung because physicians who were not and are not aware of this danger would advise the patients to "wait and see what happens." "Coming events often cast their shadows before them"—it is equally true that shadows cast by hilar infiltration due to other conditions such as tuberculosis and even normal structures are confusing. However, an infiltrating hilar shadow in a patient past middle age associated with cough, hemoptysis and the absence of tubercle bacilli in the sputum almost certainly indicates a bronchogenic carcinoma; most of these carcinomas are located at or near the hilus or root of the lung. The diagnosis of cancer of any organ cannot be definitely made by x-ray examination alone, but the more experienced the observer the greater the likelihood of an accurate interpretation. Positive roentgenograms may show a shadow produced by the new growth itself or by an area of atelactasis, bronchiectasis, pneumonitis or abscess caused indirectly by occlusion, by the growth, of a bronchus leading to a bronchopulmonary segment or segments.

In my experience, second to the roentgenogram in importance in yielding information which is helpful in arriving at a definite diagnosis is bronchoscopy. In fact, by either direct vision or biopsy or both a positive diagnosis of primary carcinoma of the lung can be made only in this manner. In 70 per cent of the patients in this series a positive biopsy of the cancer was obtained. A pulmonary new growth in the periphery or even in the hilar lesions confined to the upper lobes may be beyond the vision of the bronchoscopist. Nevertheless, valuable information can be elicited by bronchoscopy even when the growth cannot be seen, such as fixation or deformity or both due to pressure of any visible portion of the bronchial tree. The presence of blood or purulent discharge from certain bronchi serves as a lead. In this series of cases there have been no untoward results during or after bronchoscopic examinations.

Bronchography is a useful diagnostic method only to reveal occlusion of a bronchus by a small growth which does not produce a shadow in the x-ray of the chest. However, it is a harmless procedure and may be the link in the chain of evidence pointing to the possible presence of carcinoma of the lung.

Aspiration biopsy has a limited field, is often difficult to interpret and such procedures are not without danger of implanting some cells along the tract of the aspiration needle or infecting the pleural cavity with the same cells, with tubercle bacilli or other pyogenic organisms. Aspiration of the bronchial tree has in some instances revealed cancer cells which could be obtained for microscopic examination.

Exploratory thoracotomy should be resorted to far more frequently in the future than it has been in the past. This is, with the present day anesthesias and surgical technic, a relatively harmless procedure—far more so than exploratory celiotomy and attended with fewer dangerous sequellae such as adhesions. Exploratory thoracotomy is far less incapacitating than laporotomy. When it has been impossible to arrive at a definite diagnosis by all the means at our disposal this procedure should be performed at once, if a dangerous pulmonary lesion such as primary carcinoma is suspected. In our series of cases no deaths have occurred as a result of simple exploration of the chest. If direct observation and palpation of the lesion does not reveal the true nature, excision of the entire area in the lobe should be performed for immediate microscopic examination, and the diagnosis is made as is customary for questionable cases of carcinoma of the breast. If further discussion of the situation with the patient seems advisable, the wound may be closed and the patient returned to his room for further consultation. Later in the week the chest can be reopened and the definite procedure carried out. The old idea that opening the thoracic cage at operation is another form of euthanasia must be abandoned. The impression that all primary malignant tumors of the lung are slow-growing and late in metastasizing is incorrect.

Pathology

The surgical removal of primary carcinoma of the lung in a relatively early stage has brought about changes in our ideas of the origin and nature of the growth of such tumors. In the past practically all the data were based on the autopsy in very late cases, when it was impossible on account of the almost universal involvement of the lung and contiguous structures to determine the nature, origin and progress of the growth within the lung. In this series

of cases the tumors occurred at or adjacent to the hilus, the minority in the periphery of the lung. The latter seemed to spread throughout the area of the lung in which they originated by centrifugal growth, most of them apparently having arisen in the alveolar lining cells. The hilar tumors, all of which were bronchogenic in origin, grew grossly in two separate fashions. The one, an intrabronchial tumor arising apparently from the bronchial musoca, grew into the lumen of the bronchus and towards the trachea. The centripetal tendency of the growth, occluding completely or partly the primary or secondary bronchus was characteristic. The other type of hilar growth was an extrabronchial tumor which, probably arising in the wall of a secondary, tertiary or quaternary bronchus, would break through the wall and grow along outside of and often completely around the bronchus. This type of growth also showed this centripetal tendency, growing around and about the secondary and primary bronchi and then spreading directly into the mediastinum to involve the structures contained herein.

The clinical course is dependent to a great extent on the method of growth. It is, of course, obvious that the intrabronchial type will produce respiratory difficulties, cough, sputum, and hemoptysis much earlier than the extrabronchial tumor. The first symptoms caused by the latter method of growth may be, for example, interference with the venous return from the neck owing to the involvement of the superior vena cava on the right side, or recurrent laryngeal palsy on the left, or Horner's syndrome. Malignant tumors arising in the periphery are, as a rule, asymptomatic. They may be said to arise in the silent area of the lung and as they do not, as a rule, produce bronchial obstruction or erode pulmonary vessels the symptoms and signs are usually those dependent on invasion of the pleura and chest wall and, by direct extension, the brachial plexus.

In 70 per cent of the 112 patients on whom a total pneumonectomy was performed there were metastases to the bronchial and tracheal lymph nodes. This fact emphasized the necessity of performing a total pneumonectomy with dissection of these regional nodes in order to effect a permanent cure. In the remaining 215 cases that were inoperable, in addition to the metastases in the regional nodes the various organs and structures that were the site of metastases are listed in the order of the frequency of their involvement: supraclavicular and axillary lymph nodes, liver, pleura, pericardium and heart, contralateral lung, osseous tissue, brain and multiple areas in the skin and subcutaneous tissue.

The characteristic histologic structure of the tumor occurring in

this series of cases was that of a flat and squamous cell carcinoma and adenocarcinoma. Under these two main headings were included various examples such as oat cell, cylindrical cell and adenocarcinoma thought to be different forms of the same tumor. The adenocarcinoma type is pleomorphic. Sections of the tumor differ depending upon the region from which they were cut. Sixty-five per cent of the cases in this series were composed of a flat or squamous cell cancer and 35 per cent the adenocarcinoma group.

It is interesting to note that the length of life computed on the basis of the microscopic characteristics of the tumor showed that those afflicted with the squamous or flat cell type lived a greater length of time than those with the adenocarcinoma type.

Treatment

Preoperative preparation. For several days preceding operation the patient should be carefully prepared. It has been our custom to treat the patient with intramuscular injection of penicillin 30,000 units, every 3 hours, avoiding awakening the patient at night. In addition to this penicillin, aerosol should be employed. Whether or not some of the sulfonimides should be used has been questioned. It is my personal opinion that for some days, approximately 3, sulfamerazine may be administered by mouth. The patients thus have a protective blood level of this drug which apparently does no harm. It is merely an added questionable merit and so far we have not been able to observe any demerits.

However, the preoperative preparation which we consider of the greatest importance is the induction of artificial pneumothorax. The advantage of this procedure has been proved over a period of years. In the first place, it must be considered a therapeutic test, particularly in individuals in the fifth or sixth decade in which there may be a certain degree of unrecognized emphysema. Removing the lung at operation without knowing whether or not the patient can sufficiently oxygenate himself with the remaining lung may constitute a fatal error and in the past we have experienced this tragic result. The ability of the remaining lung to function sufficiently for the needs of the patient can be established before operation is performed by merely collapsing the lung on the affected side. Various tests, such as oxygen saturation of the blood at body rest and during exercise of various degrees of intensity can be ascertained. For after all to cure a patient of a malignant tumor of the lung is futile, if the patient is left with insufficient aeration surface to support normal respiration. There are other minor advantages and secondary ones associated with artificial pneumothorax, such as dimin-

ishing the size of the lung so that the mechanical handling of this structure is technically made easier at the time of operation. Second, the patient has learned to breathe with one lung previous to operation and with the increased intrapleural pressure thus avoids pleural shock on opening the thoracic cavity. Third, the blood flow through the collapsed lung is less than through the expanded contralateral lung and therefore the strain on the right heart from shifting greater blood flow through one pulmonary artery is graduated. Fourth, the location of a growth as regards the position relative to the mediastinum is often silhouetted and therefore located more accurately in the collapsed lung than with an expanded lung.

Treatment. In our present state of knowledge the only efficacious method for treatment of pulmonary carcinoma is by surgical removal of the entire organ, together with the regional lymph nodes. Medicinal and radiation therapy are only palliative, and as these tumors are, as a rule, radio-resistant, radiation therapy is of no benefit. It is interesting to note that in 215 cases of this series which were found to be inoperable at the time of exploration of the thoracic cavity, the average length of life after leaving the hospital was approximately 5 months and this in spite of the fact that every type of supportive therapy, and in many instances, radiation therapy, was employed. It is to be emphasized again that the disease runs a fatal course in 100 per cent of the patients in whom the lung cannot be removed in its entirety by operation. From an anatomic standpoint, the lung lends itself to surgical removal more readily than any other organ in the body, with the possible exception of the breast. From the point of view of the biologic characteristics of primary carcinoma of the lung surgical removal is more apt to be successful because of the relatively slow growth and spread of these tumors as compared to similar tumors in other regions of the body. Finally, the remarkable ability and tendency of the contralateral lung to undergo compensatory changes prevents incapacitation of the patient from a physiologic point of view.

Operative Technic

The operative technic now employed for one-stage total pneumonectomy in the treatment of malignant tumors is essentially the same except for closure of the bronchus, as that described by the author in 1933 in the Johns Hopkins Hospital Bulletin.[1]

A number of points in the operative technic, as would be expected, are still controversial and, as in any other operative procedure, unanimity of opinion as regards the various methods is hardly to be expected. But, after 13 years' experience and after having em-

ployed this operative technic in 327 cases, of which 112 were total pneumonectomies, it is felt desirable, with the background of this experience, to discuss certain steps in the operative procedure which are of special interest.

In the first place, the anterior approach is definitely to be preferred to the posterior or lateral for the following reasons: The width of the intercostal spaces is greater anteriorly than posteriorly and the necessity for resection of ribs is therefore, as a general rule, not necessary. This reduced the operative time and the general ill effects of the procedure upon the patient. The thoracic cavity is more quickly entered with a minimum amount of damage to the chest wall and parieties. The use of a self-retaining retractor gives sufficient exposure so that the question of operability can be promptly judged. The time consumed from the incision to the entrance of the pleural cavity is far less when the anterior approach is employed and associated with this there is a minimum loss of blood as well as trauma to tissues. If a greater amount of exposure is desired the adjacent intercostal cartilages can be incised and the ribs, usually the third and fourth, can be displaced cephalward or caudalward. Also, by slightly rotating the patient on the operating table or the table itself, if desired, the incision can be extended laterally so that the maximum exposure can be obtained. If the tumor proves to be inoperable, the minimum of operative trauma has been incurred. The operability can be determined at once with the minimum operative effort. In the event the growth is operable the dissection of the hilar structures, such as the pulmonary artery and veins which lie anterior to the bronchus, is accomplished with far greater ease and facility when the anterior approach is employed. The advantage of ligating the pulmonary artery at the beginning of the operation is obvious, the control of hemorrhage is thus more certainly assured and the greater percentage of blood normally contained within the lung is returned to the general circulation via the pulmonary veins. Bleeding from any adhesions that may exist between the visceral and parietal pleura is reduced to a minimum. If for any reason it is felt desirable to interrupt the operative procedure and perform the operation in two stages, one can do so after ligation of the pulmonary artery, provided the pulmonary veins have been left intact. If the latter are ligated, the lobe which either one or both pulmonary veins drain, must be removed, for otherwise, gangrene of this portion of the lung will ensue. It is to be noted that the bronchial veins are vestigial in character and do not function sufficiently to drain off even the blood brought to the lung by the bronchial artery, to say nothing of that from the much larger pul-

monary artery. When the pulmonary artery, which carries venous blood, is ligated, collateral circulation through the bronchial artery is at once established. The bronchial artery brings sufficient arterial blood to the lung to maintain this organ in a normal state of nutrition and the circulation through the lung is thus changed from a venous to an arterial one, whereas normally the greater amount of blood flowing through the lung capillaries is venous in character originating from the pulmonary artery, the blood flowing into the same capillary bed from the bronchial artery is arterial. Stoppage of the blood flow from the pulmonary artery by ligature of the latter, incurs a great increase in flow from the bronchial artery and thus fills the capillary bed in the lung and the bronchus of the pulmonary artery up to the point of ligation with arterial blood, containing such a high saturation of oxygen that the lung is thus rendered essentially functionless as far as further oxygenation of the blood flowing through it is concerned. The development of this collateral circulation via the bronchial artery begins after ligature of the pulmonary artery is performed. In the early days simultaneous ligation of one or both pulmonary veins invariably resulted in moist gangrene of the corresponding lobe or lobes because of the vestigial character of the bronchial veins. In the event of ligation of a pulmonary vein that portion of the lung whose venous bed is a tributary to that vein must be removed at the time of operation.

Not infrequently total pneumonectomy may be carried out with a greater degree of safety if a two-stage operation is performed, in which only the pulmonary artery is ligated as the principal objective of the first stage. This is particularly true when the lung is the site of a great deal of infection and extensively adjerent. The arterialization of the lung with a flow of more highly oxygenated blood would appear to have a beneficial effect on the pulmonary infection and therefore the patient's clinical condition.*

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*In patients suffering from pulmonary tuberculosis ligation of the pulmonary artery has a definite deleterious effect. In 8 patients the pulmonary artery was occluded with the idea of bringing about an atelectasis of the lung. The lesions were very extensive in each case and associated with large cavities. However, the change from a lower oxygen tension in the blood flow through the lung following ligation of the pulmonary artery, to the higher oxygen content of the blood flow from the bronchial artery exercised a most marked detrimental clinical and pathologic effect on the patient and lung. This was apparent by a more rapid progression of the manifestation of the disease than would have been expected had the pulmonary circulation not been interfered with at all. No atelectasis was produced and cavitation increased rapidly. This unfavorable result was attributed to the fact that the tubercle bacillus flourished in an envi-

Dividing the operation into two stages greatly diminishes the shock of the procedure. It has been found that the pulmonary vessels, the artery and veins, are best ligated with silk and in no instance has this type of ligature been known to cut through the vessel wall.

Treatment of the Bronchial Stump

Since 1942, when the method of closing of the bronchus was first reported by the author in the Annals of Surgery[2] the bronchial stump has been occluded by the use of mattress sutures of interrupted silk or cotton placed through the bronchus in such a manner that the posterior membranous portion is approximated to the anterior cartilagenous wall, somewhat proximal to the end of the amputated stump, thus creating a viable cuff from 1 to 2 cm. distal to the suture line which immediately fills with a fibrinous clot that thereafter becomes infiltrated with cells and eventually forms a plug. One of the more important steps in securing a satisfactory closure of the bronchial stump is to sew a pedicle flap of parietal pleura over the end of the stump of the bronchus approximating the pleura to the rim of the viable cuff. The use of any form of cauterization or traumatization to the end of the bronchial stump has been studiously avoided in order that agglutination of the rim of this cuff and the pleural membrane would be brought about immediately and permanently. Any foreign material such as sutures in the end of this cuff or devitalization of the rim of this cuff will militate against the immediate healing. Therefore, the bronchial stump should be sutured at least a centimeter proximal, if possible, to the point at which amputation is anticipated. Regardless of the type of suture material or the manner in which it is placed, cutting through the posterior or anterior membranous portion of the bronchus will frequently occur. This has been proved experimentally and at autopsy.[2] Unless every opportunity is therefore afforded for the bronchial cuff distal to the suture line to heal by the formation of granulation tissue within its walls leakage will follow in a rather high percentage of cases. In the event that the bronchial growth extends up towards the carina the bronchus and also the lower end of the trachea may be sutured after a diagonal incision in this structure has been made. This suture, as in the bronchus, should be tied sufficiently tight to approximate the walls of the bronchus or trachea, but not enough to cause crushing of the

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ronment of higher oxygen content. It would be interesting to find out the effect of ligation of only the bronchial artery in a pulmonary tuberculosis. The reverse condition of oxygen saturation would obtain.

tissue. If so, the sutures will be cut. They should also be placed so that the knots are tied about the cartilaginous rings, that is on the anterior surface of the bronchus or trachea. Healing of the stump takes place at the cut end and the sutures which occlude the lumen of the bronchus, usually from 4 to 6 in number, must be considered as only temporary, with their main purpose to exclude the passage of air through the bronchial stump long enough for the healing of the end of the bronchus to be completed, or sufficiently so as, in the event the sutures cut through, to form a tight and impenetrable occlusion of the bronchial stump that will not open up and allow air to pour into the pleural cavity. The healing of the end of the bronchial stump requires, as a rule, from one to two weeks, varying in different individuals, and seems to be completed in the majority of cases after a period of 10 to 14 days. However, there have been instances in our series in which the stump in one patient reopened after a month, one after 3 months and one even after 8 months. However, these fortunately eventually healed and the patient was none the worse off except for the disagreeable experience associated with walled-off empyema, which was satisfactorily treated by drainage and irrigation with penicillin.

Interrupted mattress sutures may be employed by stitching the anterior cartilaginous wall laterally, infolding the posterior membranous portion, providing the cartilaginous rings are incised at the apex of their arc, this is in the midline of the anterior surface of the bronchus. This method has been satisfactorily employed in some cases.

All types of suture material have been used, catgut, silver wire, steel wire, fascia and others and it is our opinion that interrupted sutures of silk or cotton would seem to be the material of choice.

Before the bronchial stump is sutured, after amputation of the lung, the inside of the remaining bronchus should be carefully inspected for not infrequently a blood clot or even a piece of tumor tissue may be dislodged from the lung into the primary bronchus during the course of the operation. Immediately following operation the patient is again bronchoscoped while on the operating table before returning to the ward. Often small clots and pieces of tumor tissue have been discovered not only in the bronchial stump on the operative side, but even in the trachea. If these foreign bodies were not removed aspiration into the contralateral lung might eventuate in the death of the patient.

Mobilization of the parietal pleura may be accomplished on either side by loosening the pleura from the endothoracic fascia

either anteriorly or posteriorly in the vertebral gutter. No difficulty has been experienced in obtaining a sufficient amount of pleura to cover over completely and without tension the entire raw hilar area.

At the end of the operation 150,000 units of penicillin have been introduced into the thoracic cavity. The intrapulmonary pressure, as the wound in the chest wall is closed, has been increased to not more than 10 mm. of mercury. The entrapped air is removed to the fullest extent possible by leaving a small catheter in the wound during closure. After the last interrupted suture is placed in the skin all the air that can be is removed by aspiration and the catheter itself is then withdrawn. No drainage of the pleural cavity is felt desirable even in the presence of infection, within the lung itself, and when purulent material has been unfortunately and accidentally spilled into the pleural cavity.

Since penicillin has been available, when gross infection has been present it has been our custom to introduce every other day 50,000 units of penicillin into the thoracic cavity. In addition the drug is also given intramuscularly up to 50,000 units every 3 hours. No instances of empyema have been encountered in cases so treated, and thus the necessity for performing thoracoplasties to obliterate infected dead space in the thoracic cavity has been avoided.

A word of caution should be given here in regard to the possibility of the development of interstitial pulmonary emphysema as a result of increasing the intrapulmonary pressure either too rapidly or to too great an extent, in an endeavor to hyperdistend the lung on the unoperated side for the purpose of obliterating the dead space in the thoracic cavity on the operative side. Rupture of alveoli within the lung substance itself, producing a mediastinal, plus extensive subcutaneous, as well as visceral emphysema, was encountered in one case of diaphragmatic hernia followed by death from cerebral and coronary air emboli, proved at autopsy.

The final proof of the efficacy of any method of therapy naturally is a critical analysis of the immediate and remote results. Of 327 cases of primary carcinoma of the lung, as shown in Table 3, 215 or 66 per cent were inoperable, whereas 112 or 34 per cent were operable. This ratio of the inoperable to the operable cases is far higher than it should be, for in the majority of instances the attending physician and oftentimes even the patients had been aware of a lesion in the lung for many months and often years before submitting themselves to operation. Undoubtedly, in the future, as the field of thoracic surgery is developed, this disproportion will

Table 3.—Carcinoma of the Lung
Ratio of Operable to Inoperable Cases

	No. of cases	Percentage
Operable	112	34
Inoperable	215	66
Total	327	100

be reduced. There will always be those instances in which a malignant tumor begins in the periphery of the lung, the so-called silent area, and produces no symptoms or signs until involvement of the pleural or contiguous structures renders the case inoperable. Fortunately, this group comprises only about 10 per cent of the cases of malignancy of the lung, 90 per cent occurring near the hilus and producing warning signals early in the process of the disease. Unless for palliative reason, to rid the patient of an infected lung due to neoplastic bronchial obstruction, for example, pneumonectomy should not be performed if the tumor has involved contiguous structures. Therefore, inoperability would be manifest by involvement of the parietal pleura or any of the underlying structures.

Table 4.—Cases of Inoperable Carcinoma
According to Years

	No. of cases
1934	2
1935	3
1936	9
1937	17
1938	22
1939	14
1940	21
1941	16
1942	22
1943	19
1944	19
1945	37
1946	14
Total	215

Table 4 reveals the number of cases, i. e., 215, of inoperable carcinoma of the lung which have been subjected to operation from January 1934 until July 1946. This number does not include those patients that were clinically inoperable. The clinical findings which we have found to indicate a spread of the tumor beyond the con-

fines of the lung and therefore to render the case incurable from a surgical standpoint are the following: metastases to the opposite lung or mediastinum, direct metastases to brain, osseous tissue liver, skin, axillary and supraclavicular glands, pleural effusion, clear or serosanguineous, continuous pain to shoulder or referred down the arm, Horner's syndrome, left recurrent laryngeal palsy or hemiparalysis of the diaphragm.

Table 5.—PNEUMONECTOMY FOR CARCINOMA OF THE LUNG
Operations and Mortality According to Years

	No. of Operations	No. of Deaths
1933	2	0
1934	1	1
1935	5	1
1936	4	2
1937	5	0
1938	7	2
1939	6	2
1940	10	0
1941	13	3
1942	9	4
1943	9	2
1944	12	2
1945	15	5
1946	14	1
	112	25

Although the number of cases of inoperable carcinoma of the lung have apparently increased since 1939, when Table 4 is compared to Table 5, there is very little fluctuation in the ratio of operable to inoperable cases, over the same period of time. All patients with lesions of the lung which have been diagnosed probable malignant tumors should be explored regardless of the size or position of the tumor or the age of the patient. In the absence of clinical signs or symptoms of a spread of the disease from within the limits of the lung itself the question of operability can be determined only by exploration of the chest.

In this series of cases, there have been 112 in which total pneumonectomy was performed for carcinoma of the lung.

Table 5 represents the number of total pneumonectomies done each year for carcinoma of the lung, together with the deaths occurring within one month of the operation. All deaths within this time limit were considered in the group of immediate postoperative

mortality because of the fact that the patients had remained in the hospital that long and in spite of the fact that in some instances death was in no way connected with the actual operative procedure. From 1933 through 1939 there were 30 cases with 8 deaths, or a mortality of 27 per cent. From 1940 through half of 1946, 82 patients were operated upon with 17 deaths, or a 20.7 per cent mortality. Thus, in spite of an increase in the number of patients there was a 5 per cent decrease in immediate postoperative mortality. Undoubtedly in the future this hospital death rate will be decreased because of several reasons, such as earlier reference of cases by the general practitioners, improvements in operative technic, chemotherapy and anesthesia. In addition, postoperative care has improved remarkably. Penicillin is now given intramuscularly, by inhalations, and intrathoracically, so that the chance of developing a postoperative empyema is almost nil.

Important as the immediate operative mortality is, and it should be very jealously guarded, the efficacy of the operative procedure should also be judged by the ultimate results. The duration of life following total pneumonectomy for carcinoma of the lung is shown in Table 6. It is to be noted that patients dying after various periods of time are so charted in comparison to patients still living following operation. Those dying following operation who died less than one month afterwards were considered an operative mortality. The total operative mortality of the 112 cases for total pneumonectomy for carcinoma of the lung was 22 per cent. Of the patients who are now dead, but who lived for various periods of time after operation, i. e., from one month to 6 years, the number surviving the different periods of time was 44. This group of cases made up 39 per cent of the total. Reference must be made to the fact that of the 215 cases of inoperable carcinoma comprising this series, the average duration of life after exploration of the thoracic cavity was 5 months, so that even in the group in Table 6, who are now dead but lived various periods of time following operation, the average duration of life after removing the lung was greater by far than in those patients in whom the lung could not be removed. Of the patients living at the present time, 39 per cent of the total, or 43 patients, have survived from 1 month to 13 years. Of this group, 12 patients have lived 5 years or more, one 13 years, one 11, two 9 and two 6. As they are still living there is a possibility they may live for many years. It would seem desirable to call attention to the fact that all these patients, except one who was a professional boxer, have been restored to their normal activities. They have been able to return to their former vocations and even recreations,

such as golf, swimming, fishing and hunting. In all except the occasional case, since it has not been found necessary to perform a thoracoplasty, no deformity of the patient is visible from the removal of the affected organ. The remaining lung expands to fill the dead space. This intrathoracic readjustment has been reported in detail elsewhere. If these results are compared to those obtained from the surgical treatment of carcinoma of the thyroid, breast,

Table 6.—PNEUMONECTOMY FOR CARCINOMA OF THE LUNG

Duration of Life	No. of cases	Total	Percentage
Patients dying after various periods of time:			
Less than 1 month	25	25	22
1 month to 6 years			
1 monto to 6 months	20		
6 months to 1 year	10		
1 year or more	6		
2 years or more	2		
3 years or more	2		
3 years or more	3		
4 years or more	1		
5 years or more	1		
6 years or more	1	44	39
Patients living			
1 to 6 months	12		
6 months to 1 year	2		
1 year or more	8		
2 years or more	5		
3 years or more	4		
5 years or more	4		
6 years or more	2		
9 years or more	2		
10 years or more	2		
11 years or more	1		
13 years or more	1	43	39
		112	100

esophagus, stomach and large and small intestine, reported over a corresponding length of time (13 years) it will be evident that removal of the lung for primary carcinoma offers at least as great, if not greater, probability of permanent cure as the surgical treatment of carcinoma of any other organ in the body.

Of the group of patients who lived for some time (up to 6 years) following operation, but who are now dead, the majority were definitely improved by relief of the coughing, hemoptysis and often extensive pulmonary suppuration with its attendant discomfort and manifestations.

Conclusions

An otherwise fatal disease, primary carcinoma of the lung, can be satisfactorily treated by surgical removal of the entire organ. Surgical measures short of total pneumonectomy are not efficacious. Postoperative mortality and longevity are at least as good as, if not better than, the postoperative results following the surgical treament of carcinoma of other organs.

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THROMBIN AND ITS CLINICAL APPLICATIONS

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In the past decade there have been a number of practical clinical applications resulting from studies of the blood clotting process. The uses of vitamin K, heparin, and dicoumarol are well known. Another development in this same period has been the production of potent thrombin preparations, and the use of thrombin in the clinic, both as a hemostatic agent and as a technical aid in certain plastic operative procedures. I would like to cover briefly the development and uses of thrombin. But before discussing thrombin, it might be well to review the mechanism of hemostasis.

In hemostatis, there are two separate blood clotting mechanisms of importance. The first of these mechanisms is simple clumping of platelets and the formation of platelet thrombi. Phylogenetically, this is the oldest mechanism and is the only one possessed by certain lower forms, as the arthropods. In mammals, however, it is of only limited importance in controlling bleeding. Of prime importance is the other mechanism—the formation of the fibrin clot. The formation of fibrin is the end result of a complex series of reactions, which may be represented as a three stage reaction. In the first stage, thromboplastin is liberated primarily from the blood platelets and injured tissues. In the second stage, thromboplastin thus liberated reacts with two components of the plasma, calcium ion and a plasma protein, prothrombin. Thrombin is formed. In the final stage, thrombin reacts with the plasma protein, fibrinogen, to form the fibrin clot.

In hemostasis, the time required for these various reactions is of great importance. Also, to understand the sequence of events in the clotting process, a knowledge of the quantitative changes of the factors in the reaction is needed. Some of these changes are shown in a simple experiment in which normal blood is drawn in the usual manner from the antecubital vein. It is placed in a test tube without an anticoagulant and allowed to clot. Serum is obtained at intervals and is titered for prothrombin and for thrombin. One thrombin unit is that amount which clots 1 c.c. of fibrinogen in 15 seconds. One unit of prothrombin forms one unit of thrombin. Normally, in human plasma, there are about 325 units of prothrombin per c.c.

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Read before the fifteenth annual Postgraduate Surgical Assembly of The Southeastern Surgical Congress, Louisville, Ky., March 10, 1947.

At the end of 10 minutes, just before clotting occurs, the amount of prothrombin converted to thrombin is so small as to be negligible. Beginning about the time clotting starts, thromboplastin becomes available in increasing quantities from platelet breakdown. This speeds up the conversion of prothrombin to thrombin, so that at the end of 1 hour, less than 20 per cent of the original prothrombin remains and at the end of 2 hours, only a trace of prothrombin is present. The thrombin, on the other hand, rises slowly and reaches its peak about one half hour after the blood is drawn. It then decreases so that at the end of 2 hours, only a trace remains. This rise and fall in thrombin titer has been called the "thrombin tide" by Smith.[1] However, it is a low tide, and the amount of thrombin never corresponds to the amount of prothrombin converted. This is shown by a comparison of the amount of thrombin present at the height of the thrombin tide with the amount of prothrombin which has been converted to thrombin at that time. There are 2 units of thrombin present, in contrast to 75 units of prothrombin which has been converted to thrombin. Thus, there is a destruction of 73 units, or about 97 per cent, of the thrombin formed.

The agent responsible for this destruction of thrombin is antithrombin. Antithrombin apparently is widespread throughout the body and is present in tissue fluids generally. At any rate, injection of thrombin into the body cavities or subcutaneously, or incubation of thrombin with tissue juices results in the destruction of most of the thrombin rather rapidly, similar to destruction of thrombin in serum. This destruction of thrombin by antithrombin is a very effective protective mechanism of the body whereby thrombin is largely inactivated locally before it has time to be absorbed and cause intravascular clotting. This is in accord with toxicity studies, in which thrombin was found to be lethal only if injected intravenously.[2]

It should be pointed out that the time required for the conversion of prothrombin to thrombin is many times longer than the final, or thrombin-fibrinogen, phase of the clotting process. For example, with one unit of prothrombin, an excess of thromboplastin and optimal calcium, it requires about 3 minutes for conversion of the prothrombin to thrombin, but only 15 seconds for the final or clotting phase—a ratio of about 12 to 1. This shows perhaps why thromboplastins are such poor hemostatic agents—too much time is consumed in the formation of thrombin. Also, this led naturally to the idea of using preformed thrombin in hemostasis, eliminating the preliminary phases of clotting. However, thrombin is easily inactivated, and when we started work on this problem, the first

obstacle was the lack of a satisfactory method of preparing potent and stable thrombin.

The research group at Iowa of which I was a member started work on the purification of thrombin about 10 years ago.[3] I won't bother you with the details of this work, but will merely indicate in a general way the method that finally evolved for the preparation of a thrombin many times more potent than the usual product heretofore obtained. This was essentially a problem in protein chemistry. Bovine plasma was used as a source of prothrombin. The prothrombin was first precipitated at its isoelectric point, pH 5.3, and then absorbed onto and eluted from a colloid, magnesium hydroxide cream. After precipitation again at the isoelectric point, the prothrombin was then converted to thrombin. The thrombin was further purified and then finally precipitated and dried with acetone. Seegers and McGinty,[4] working in the Parke Davis Research Laboratories, have made a number of improvements in this method, and have obtained extremely potent and practically pure thrombin. Thrombin has been made in recent years by other methods,[5,6,7] but none of these products appears to be as highly purified as the product mentioned. This becomes important, particularly when one is using animal prothrombin as a starting material, as a large content of foreign protein might be disadvantageous. Studies have been made on the possible antigenicity of bovine thrombin, both in animals and in man, and all have been negative. In accord with this has been the absence of any sensitivity reactions in patients who have been treated with thrombin repeatedly.[8]

The thrombin obtained is a conjugated protein readily soluble in water. It contains carbohydrate in the molecule—hence is a glycoprotein. In solution it is stabilized by the addition of carbohydrate, and thrombin commercially available contains ordinary table sugar, sucrose, as the stabilizing agent.[9] In the absence of sugar as a stabilizer, thrombin is a white fluffy amorphous powder. Moderately potent preparations contain about 750 units of thrombin per mg.; that is, 1 mg. will clot 750 c.c. of standard fibrinogen solution in 15 seconds.

After a method of producing stable and potent thrombin in small quantities was available, work was started on animals to test its hemostatic effect.[10] It soon became obvious that thrombin was of no value in controlling arterial bleeding, except from very small vessels. However, it was remarkably effective in controlling bleeding from oozing surfaces.

After these promising results with animals, we first tried the use

of thrombin in the control of hemorrhage in patients.[8] It was soon found that merely applying thrombin to a briskly bleeding surface was usually not adequate. The blood would clot practically instantaneously on contact with the thrombin, but it was the shed blood that was clotted, not the blood just issuing from the vessels. In fact, the clotted blood acted as a barrier between the thrombin and the bleeding point. So a spray atomizer or a jet under high pressure from a needle and syringe was used on a freshly sponged surface. This is usually a satisfactory method of application, providing strong solutions of thrombin are used. Better control of bleeding was often obtained by using the dry thrombin and rubbing it into the bleeding surface. This is quite wasteful of the thrombin, but it still appears to be one of the best methods of application to bleeding bone.[8] Application of thrombin solution by a cotton pledgelet or gauze saturated with thrombin will control the bleeding promptly, but on removal of the cotton, the clot is usually broken from its anchorage in the tissue, and bleeding starts again. The hemostatic clot obtained by thrombin is at the opening of the vessels and on the surface, not deep in the tissue. Hence, it is essential to leave the hemostatic clot in place. For this reason, sponging of an area after hemorrhage has ceased usually causes oozing to start again.

To obviate these difficulties in the application of thrombin, one may use any of a number of absorbable sponge preparations that have been introduced in the last few years. One preparation is fibrin clotted out in the form of a sponge, so-called fibrin foam.[11] Another preparation is a gelatin sponge.[12] A third preparation is oxidized cellulose, which has been used mainly as a gauze.[13] The first two of these take up large amounts of fluids readily. On wetting they shrink considerably and become quite flexible. The gelatin preparation has somewhat greater tensile strength than the fibrin. Of the three, gelatin and fibrin appear to be absorbed most readily. The oxidized cellulose is quite acid in reaction, and will destroy thrombin. If it is used as a vehicle for thrombin, it must first be neutralized.[14] A sponge made from cornstarch has not proved satisfactory. Another vehicle that has been used successfully is freshly prepared fibrin, made up as needed from dried bovine fibrinogen.[15] The dried fibrinogen is readily soluble in saline solution. The fibrinogen solution can then be clotted with thrombin and the clot, with added thrombin, applied to the bleeding area. The clot from ordinary plasma is not satisfactory for use in this way, as its antithrombin will inactivate much of the thrombin. There was a question as to how the body would handle a heterologous fibrin. Biopsies taken from patients through sites in which bovine fibrin had been used

indicate that it is readily replaced by ingrowing fibroblasts, and shows no evidence of a foreign body reaction. No differences in the rate of organization of purified bovine fibrin and human fibrin were observed.

Thrombin, applied by any of the various methods mentioned, has been used as a hemostatic in a wide variety of circumstances. It controls the bleeding promptly from minor wounds in patients with a bleeding tendency. In such patients, less data are available on the use of thrombin in major operative procedures. Reports of the successful use of thrombin in hemostasis are numerous in the field of neurosurgery, particularly in controlling dural bleeding and bleeding in tumor beds and along venous sinuses.[16] A lengthy list of successful reports could be compiled of its use in various other surgical procedures. It appears to be particularly valuable in bone and liver operations, in operative procedures on the nose and faucial tonsils, and in controlling bleeding in the prostatic bed, either after suprapubic prostatectomy or after transurethral resection. Relatively few failures have been reported.

In addition to its use as a hemostatic agent, thrombin has been widely employed either with plasma or with purified fibrinogen in plastic surgical procedures. Fibrinous adhesions have been used to glue the tissues together. Need for suturing may even be obviated. This has been used in nerve grafts, bone transplants, and at times in closing traumatic lacerations.[15] Fibrin formed *in situ* with thrombin has been used also to obliterate tissue defects, as the dead space after radical mastectomy. Perhaps greatest use has been in the fibrin fixation of skin grafts. Successful results, with a high percentage of takes, have been reported by several authors.[15,17] A number of technics for the application of thrombin and plasma or fibrinogen have been used. Tidrick and Warner[17] have applied plasma to the graft, and have flooded the recipient bed with thrombin. The use of thrombin on the bed aided in hemostasis. Although the graft becomes firmly anchored to the bed with fibrin fixation alone, it appears that better results are obtained by using sutures and dressings in addition.

In closing, perhaps a word would be in order concerning the use of the absorbable sponges and gauzes alone as hemostatic agents. In reports of their use without thrombin, reference is made frequently to the need for holding the absorbable material firmly in place for several minutes to allow it to become anchored, and that firm anchorage is often not obtained for 10 minutes or longer. One might expect some such time relationships, because presumably such materials act by providing stasis and a surface for rupture of

platelets. The thromboplastin thus liberated, even with massive platelet rupture, is relatively small, so that the conversion of prothrombin to thrombin would be relatively slow.

In conclusion, thrombin appears to be a very useful adjunct in surgical technic, both in the field of hemostasis and in plastic procedures. Now that thrombin is available in quantity, wider use of the coagulant under varying circumstances is needed to determine the best means of utilizing it. For hemostasis it appears that its use with one of the vehicles, as gelatin sponge, gives the best results.

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THE CONTROL OF HEMORRHAGE IN OTOLARYNGOLOGY

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THE control of hemorrhage in connection with any surgical procedure is a subject to which much time, thought, and training have been devoted in the curriculum of the surgeon. We, as surgeons, have learned to act with celerity and precision in arresting such hemorrhage. We have learned to maintain our poise and not to allow ourselves to be hurried in approaching the proper planning of our technic. We have learned to plan in advance to avoid trauma to the vascular tree, and to avoid those vessels which might cause excessive or dangerous hemorrhage. We have, in the operating room, a calm, detached, almost scientific attitude toward the subject. Not so with the average layman. From his viewpoint hemorrhage is a very terrifying experience, and inasmuch as all the bleeding he ever encounters results from trauma, or occurs spontaneously from one of the body orifices, it is quite likely to be severe in type. Those hemorrhages which involve the field of otolaryngology are especially likely to be alarming, since there is encountered not only the fear of the possibility of the patient bleeding to death, but also the accompanying fear of strangulation on the accumulation of clots, which may occur if the bleeding fills the air passages. The control of hemorrhage, therefore, in the field of otolaryngology assumes great importance to our interested layman and his family or friends, and becomes a field in which we must display unusual prowess. Quite often considerable prestige may accrue or be lost to a surgeon, depending upon the manner in which he may handle such a case of bleeding.

HEMORRHAGE FROM THE EAR

Rarely ever is bleeding from the ear more than minor in character, but occasional cases of severe bleeding may occur as a complication of trauma which has ruptured the tympanum or fractured the skull through the temporal bone. Minor bleeding from the ear may result from trauma to the external auditory canal. In such a case it is usually small in amount, but may be persistent. There is little to be done except very light packing of the canal. The use of small strips of oxycel is excellent for such packing. Blood may collect behind an intact tympanic membrane as aspirated blood

Read before the fifteenth annual Postgraduate Surgical Assembly of The Southeastern Surgical Congress, Louisville, Kentucky, March 10-12, 1947.

from a severe nasal hemorrhage. It may also occur as a complication of intracranial procedures. In such cases treatment is best of the expectant type, since an attempt to evacuate the blood by myringotomy and politzerization may carry infection into the cranial cavity. As a complication of nasal hemorrhage there is little to be done other than the control of the nasal bleeding.

Hemorrhage from the lateral sinus may complicate a mastoidectomy in which the sinus has been exposed, occurring as either a primary or secondary affair. If it occurs while the operative procedure is being performed, packing of the sinus is most effective. Should there be a severe hemorrhage from the external auditory canal following such a surgical procedure, a secondary hemorrhage from the lateral sinus is thereby indicated, and the wound should be reopened and the sinus packed.

Hemorrhage from the Nose

Nosebleeds are the most common hemorrhages which occur in otolaryngology, and are usually minor affairs very frequently not requiring the services of a surgeon: but a severe nasal hemorrhage can be both a harrowing and a fatal experience. Nosebleed may arise from a variety of local causes. Most frequently it is some small ulceration of the septum, or a badly deviated septum which distorts and bends the vessels in such a fashion that they tend to rupture. A deviated septum may also cause such a disturbance of the airstream that local areas are dried and crusted, and tend to ulcerate. Malignant neoplasms in the nasal cavity, the correct diagnosis of which can be established by biopsy, are a source of severe hemorrhage. Hereditary hemorrhagic telangiectasis, or Osler's disease, may affect the nasal mucosa as well as other mucous membranes. Syphilis may play its role. One of the most severe nosebleeds I ever saw resulted from nasal diphtheria. Hypertension is often a complicating factor. Nosebleeds often complicate head injuries, and may follow nasal or sinus surgery. In each of these conditions the control of hemorrhage is frequently the initial and sometimes recurring problem.

The first rule in the treatment of nasal hemorrhage should be to locate the bleeding point or points. Quite frequently the bleeding is so severe as to make any attempt to localize the source of the bleeding very difficult, and to make even an examination of the nasal cavity difficult, if not impossible; and then when it has stopped the source of the bleeding may be equally difficult to find. If the bleeding point can be located it should be sealed with cautery, acid, or electrocoagulation. If the bleeding is severe, or if there are large

clots filling the nasal cavity, a suction tip is very useful in removing the clots and blood rapidly enough to trace the point of hemorrhage. It is quite often advantageous to slow the degree of bleeding after removing the clots before continuing the search with the suction tip. To do this, placing temporary packs of adrenalin in the nose can be quite useful. The use of some local anesthetic such as 10 per cent cocaine or 2 per cent pontocaine solution containing adrenalin is an even better procedure, since thereby we obtain some measure of local anesthesia in the area. We also obtain more room to maneuver with the shrinking of the turbinated bodies. Cautiously removing our packs and using the suction tip to explore the nasal cavity we can usually find the source of the bleeding. Often a small blood clot in a ruptured vessel will protrude from the surface of the mucosa, and removal or displacement of this will cause a recurrence of the bleeding. Having located the area of the bleeding point, we can again pack our local anesthetic solution around it to secure more adequately anesthesia for the coagulation control.

When the amount of hemorrhage is so profuse that the bleeding point cannot be located, whence to proceed to the immediate control, it is well to exercise some measure of temporary control to prevent further loss of blood. This is best accomplished by means of tightly packing the nasal cavity. Packing of the nasal cavity for this purpose is probably best done by the use of cotton tampons. These tampons should be lightly rolled, about as large as a lead pencil, and of sufficient length to reach from the nares to the choanae. Such tampons are easy to insert and quite useful to exert pressure equally in all directions. They should be moistened before insertion, preferably with some solution such as thromboplastin. A careful count of the number of these tampons inserted should be made and recorded since they may be left for from 24 to 48 hours. In the insertion of these tampons a definite order should be followed. The first one should be placed on the floor of the nose, and then carefully anchored under the inferior turbinate. Suction can be used after the insertion to determine whether bleeding has continued. The second tampon is then placed in the highest accessible portion of the nose, and the suction used to cleanse the cavity. The next one is placed upon the floor, on top of the first; another in the upper portion, and in this manner the entire nasal cavity is filled. The tampons may be wedged tighter by the insertion of forceps which are then opened allowing room for the placing of another tampon. Suction can be used as desired to keep the cavity clean and allow the accurate placing of the tampons. Often the method of insertion described will enable one to locate the general area of the

bleeding as above or below the middle turbinate, and anterior or posterior in the nasal cavity. The use of a posterior nasal pack is seldom necessary with this procedure, and there is little possibility that the packing will be dislodged into the postnasal space. These tampons should be removed at the expiration of about 48 hours because of the danger to the sinuses and the ears. Frequently upon removal of the tampons bleeding will recur, and they must be replaced. Such packing should not be left in the nose too long, however, since the nasal mucosa will become macerated and abraded and new bleeding points created. Usually after 48 hours the blood flow will be sufficiently decreased so that the source can be accurately located, and we may proceed to a more direct and permanent method of control.

A relatively small vessel may usually be controlled with pressure and the adrenalin solution, followed by the application of acid. A larger vessel may require the use of the actual cautery of electrocoagulation. Either local anesthesia or general anesthesia may be used. If the latter, sodium pentothal is preferable since the inhalant anesthetics are dangerous in the presence of the cautery or diathermy. In general anesthesia it is well also to insert a postnasal pack, pulling it into place through the opposite nostril. It is also advantageous, if possible, to elevate the head in order to reduce the blood flow in the vessels. Any nasal packs are then removed, and the suction tip again used to follow the source of the bleeding. By touching the coagulating electrode tip of the diathermy to the suction tip, the bleeding point is coagulated and bleeding stopped. The suction will not only permit us visually to control the point of application of the current, but will also keep the field sufficiently dry to permit the effective use of the coagulating current. Pressure and the adrenalin tampon may be necessary in order to control bleeding sufficiently to permit the use of this technic. After some degree of control, or even complete control, it is well to inspect carefully the surrounding mucosa. Dilated vessels can frequently be detected on the periphery of the area, and it is quite advantageous to coagulate these at some little distance from the actual source of the bleeding. If the actual live cautery is used in place of the diathermy current a sharp flat point seems most effective, and the cauterization should be carried well through the mucosa in order to secure effective control.

Nosebleed following skull injuries or nasal operations may be so severe as occasionally to require ligation of a main artery supplying the nose. The traditional surgical approach for control of such epistaxis has been to ligate the external carotid artery. Should

the bleeding then continue the common carotid is ligated. However, such extensive interruption of the blood supply is not always necessary. The largest source of blood supply to the nose is the sphenopalatine artery, which is a branch of the external carotid. Hemorrhage arising from the injury of this vessel or the facial vessel may be treated successfully by the ligation of the external carotid. However, the anterior and posterior ethmoidal arteries, which are branches of the ophthalmic artery springing from the internal carotid, also contribute extensively to the arterial network supplying the interior of the nose. Because of the efficient communication of the circle of Willis, ligation of the internal carotid artery will not control hemorrhage from the ethmoidal arteries, and the operation is therefore not justifiable simply to reduce the blood flow. The common carotid artery should not be closed unless epistaxis is due to the rupture of an intracranial aneurysm. While the collateral circulation is adequate under normal conditions, anemia due to hemorrhage may lead to serious cerebral damage. Before any vessel is ligated the source of the bleeding should be determined. Hemorrhage from above the middle turbinate indicates a leakage from the ethmoidal arteries, while the sphenopalatine and facial arteries are responsible for bleeding below the middle turbinate. If the amount of bleeding is profuse, the source may be determined by observing the effect of packing different regions of the nasal cavity. Again the use of digital pressure on the common carotid artery should arrest hemorrhage if from the sphenopalatine artery: if the flow is not diminished by such digital pressure, the bleeding originates from the ethmoidal arteries.

In such case, the ligation of the ethmoidal arteries can be accomplished by this technic.[4] Through a curved incision situated medial to the inner canthus, and about 2 inches long, the periosteum is incised and elevated from above, downward and backward to a depth of about 1½ inches from the bridge of the nose. The vessels may then be observed passing in a cuff of connective tissue to the foramen in the suture line between the frontal and ethmoid bones along the inner wall of the orbit. A retractor can be used to push the orbital contents downward and outward. The anterior branch can be ligated or closed with a silver clip, or coagulated with the diathermy. Because of its depth the posterior vessel is best coagulated with the diathermy current.

Nasopharyngeal Hemorrhage

Bleeding in the nasopharynx may have its origin in a variety of conditions. Tumors, surgery, infection and abscess formation about

the tonsils or retropharyngeal spaces, may all cause hemorrhage of varying severity. Tumors of the postnasal space are usually fibromata. While these do bleed spontaneously, the most severe hemorrhage results from attempts to excise such growths. Such tumors should have preliminary radiation with radium or deep x-ray, which will cause sufficient fibrosis of their blood vessels to make excision a safe procedure.

Occasional secondary hemorrhage may result after adenoidectomy, and in such cases it is usually associated with a tag of adenoid tissue that has been allowed to remain. The excision of such a tag and packing of the post nasal space for a short time usually suffices to control this bleeding. Sometimes there are vessels underlying the adenoid mass which are sufficiently large to require ligature, and they can be secured with an artery forcep and tied. Packing inserted into the post nasal space should not be allowed to remain over 24 hours, due to the danger to the ears.

Unusually severe hemorrhage may result from infection in the retropharyngeal or lateral pharyngeal space. Such bleeding may complicate a peritonsillar abscess, or a retropharyngeal abscess which has extended into this space. The infectious process extends to the internal carotid artery, causing a weakening of the wall of this vessel with rupture and formation of a false aneurysm. The walls of the abscess cavity may thus form the wall of the false aneurysm, and, as such, may rupture spontaneously or be inadvertently opened by the incision of the abscess. Pressure may cause such an aneurysm abscess cavity to burrow upwards into the soft palate or into the external auditory canal where rupture may occur. Treatment of these conditions must be prompt and bold, for it is said that this condition produces the highest mortality rate of all otolaryngologic hemorrhage. A single fulminating hemorrhage has resulted in death before anything could be done. Ligation of the common carotid artery is urgently indicated. If there is evidence of infection in the lateral pharyngeal space, and should bleeding occur from the nasopharynx, the pharynx, or even the ear, the common carotid artery on that side should be immediately ligated. Delay may result in a fatal outcome. The intracranial complication which may arise from the sudden interruption of the blood supply must be accepted as a calculated risk, for these hemorrhages, occurring from the nasopharynx or pharynx as a complication of an infectious process, are usually rapidly fatal. Salinger and Perlman reported an extensive study of such cases.[1] They found that the external carotid artery was the site of rupture in a few cases but that most frequently it was the internal carotid which was affected.

Most of the cases were in children also, which is fortunate in view of the drastic interruption of the blood supply necessary.

Perhaps one of the most frequent causes of hemorrhage occurring in the pharynx is the result of tonsil surgery. These may be either primary or secondary in type. Severe primary hemorrhage during tonsillectomy can be minimized by careful selection of cases, with particular reference to the patient's clotting and bleeding time, and other systemic conditions which are known to cause hemorrhagic complications. Cases with recent tonsillar infection should be allowed to "cool off" before attempting a tonsillectomy. Careful surgical dissection along the capsule, preferably blunt dissection, should be combined with ligation of all bleeding points. In cases performed under local anesthesia, minimal use of adrenalin will facilitate the location of such bleeders. A careful search of the fossa at the conclusion of the operation will often reveal veins which have been wounded, but which have retracted and ceased bleeding. Ligation of such vessels at the time of operation will markedly reduce the incidence of hemorrhage. In spite of this great care, however, there will be a certain number of cases of hemorrhage occurring within the first 24 hours. In such cases, the bleeding vessels must be located and ligated. Removal of any clots or of poorly formed clots in the fossa will be necessary. The injection of novocaine and adrenalin solution in the area of the bleeding is highly recommended. The severity of the bleeding is reduced, and the field anesthetized thereby, in order to make the search and ligature less painful to the patient. It may not be scientifically correct to inject through such a field, but practically it is very effective, and I have never seen any infection or untoward results from its use. It is most effective in controlling the bleeding which is of a general oozing nature, and in which no specific bleeding vessel can be located. The use of Monsell's solution, tannic acid, or other so-called astringents, is mentioned but not recommended. The employment of such drugs often causes a secondary slough with more severe resultant hemorrhage. The practice of sewing sponges in the fossa and of suturing the pillars together is likewise not recommended. If dissection is kept clean, all tags removed, and the bleeding points carefully ligated, such procedures are not necessary.

Secondary hemorrhages occurring from 3 to 8 or 9 days after tonsillectomy are usually not very severe, but sometimes more difficult to control. They frighten the patient far more than many primary hemorrhages. Removal of the clots which have formed, followed by gentle pressure with a gauze sponge, will control most

such cases. Sometimes the bleeding will have ceased before we see the patient, and if such is the case and a clot is present in the fossa, allow it to remain. The use of the novocaine and adrenalin solution injected about the granulation is again very effective, as in the primary bleeder. It alone will often suffice to control the bleeding in these late cases. Whatever measures are used must be gently employed since we may cause considerable damage from rough treatment that may be the basis for another hemorrhage at a later date. Since so many of these postoperative hemorrhages are the result of separation of a slough in the tonsillar fossa, it follows that measures to prevent further tissue damage will lessen the possibilities of further bleeding. Cleanliness and use of the throat muscles are very important "musts" to aid us in achieving this end. The tonsil patient who has had a secondary hemorrhage ought to be hospitalized and kept under observation for a few hours. Small doses of morphine are valuable and often sufficient to control a small amount of bleeding. Ice often has a good effect, especially when combined with morphine. Each such patient ought to have a blood count, for it is often surprising how much blood can be swallowed from one of these "insignificant hemorrhages." Chemotherapy, especially the trochees, and the chewing gums which have come into widespread use recently are doing much to reduce the incidence of secondary tonsillar bleeding.

Hemorrhage from the Mouth

Bleeding from the mouth may have its source in one of several places, from the mouth itself, possibly from the postnasal space, the pharynx, esophagus, or the tracheobronchial tree. The history of the bleeding and the type of blood is rarely of much value in determining the locale of the bleeding. In bleeding from the nasopharynx some blood will appear in the nose: often in bleeding from the esophagus there will be some vomiting and tarry stools, and in bleeding from the tracheobronchial tree, a cough productive of clots and old blood is quite likely. To aid us in our determination of the source of the bleeding we must employ the nasopharyngoscope, and the postnasal and the laryngeal mirrors. In such manner we may discover the actual point of bleeding or approximate its location. Blood seen to be coming from below the vocal cords necessitates further search with the bronchoscope.

Bleeding from the esophagus may be the result of esophageal varices, neoplasms, peptic ulcers, and foreign bodies. A study of the esophagus with the fluoroscope, and by roentgenograms will often establish the nature of the lesion. This should be followed

by esophagoscopy. The amount of bleeding from an esophageal varix may be quite severe. Often the first indication of such a lesion is a massive hematemesis or massive gastrointestinal bleeding, with tarry stools. The treatment of such varices should be either the injection of the veins with 5 per cent sodium morrhuate through the esophagoscope, or electrocoagulation followed by the use of the sclerosing agent. Often the primary control is best done by electrocoagulation and then the veins may be treated with the sclerosing solution in repeated treatments. This latter course obviates the necessity of using large amounts of sodium morrhuate at one time, though Moersch reports using as much as 9 c.c. at one time.[2]

The treatment of hemorrhage from neoplastic growths in the esophagus is not very successful. Electrocoagulation may be used with considerable success through the esophagoscope, if the bleeding point can be accurately located in the mass. Often this is very difficult, and the added trauma of the instrument may produce more bleeding. Implantation of radon seeds can be performed through the instrument and has been found to be of some value in controlling minor bleeding.

Foreign bodies have been reported as a source of bleeding and even fatally when erosion has taken place into the descending aorta. Peptic or tuberculous ulceration of the esophagus has also been reported as involving the descending aorta, followed by fatal hemorrhage.

Blood seen below the vocal cords should be further investigated by the use of the bronchoscope. Bleeding from the tracheobronchial tree may be associated with tuberculosis, neoplastic diseases, syphilis, adenomata, hemangiomata, bronchiectasis, broncholithiasis, or neglected foreign bodies. The roentgenogram will usually determine the type of lesion, and when necessary biopsy will complete the diagnosis. An hemangiomata can be seen through the bronchoscope and can be controlled with the electrocoagulation diathermy, using a special long insulated bronchial electrode. This electrode is also the method of choice for controlling any bleeding from the adenomata or malignant neoplasms. Implantation of radon seeds can be useful also in controlling the bleeding from these types of growths. Removal of a calculus or neglected foreign body will cure any bleeding from such a source. Of course it is desirable and often necessary to avail ourselves of other types of surgical procedures in the treatment of these conditions, and such procedures as pneumonectomy, lobectomy, chemotherapy, postural drainage, etc., may be employed, and such measures may be necessary adjuncts in the

control of bleeding from the lung. The use of the bronchoscope in control of hemorrhagic conditions within the lung is limited to those conditions in which the pathology can be found in one of the branches of the tracheobronchial tree available to examination with the bronchoscope.

In every case of hemorrhage where no definite local cause for the bleeding can be established, there should be a careful general examination with appropriate laboratory studies. We must exclude cardiovascular diseases with hypertension, and the various hemorrhagic states. Bleeding often occurs in the acute infectious diseases, and our blood studies will be of great value in determining the type of treatment to be followed. A low platelet count is found in both the primary and the secondary type of thrombocytopenic purpura hemorrhagica. In the primary type a splenectomy is the only procedure that has given uniformly good results. In the secondary type are many of the blood dyscrasias such as pernicious anemia, myelogenous leukemia, lymphatic leukemia, aleukemic myelosis, and aplastic anemia, for which specific types of therapy must be adopted. In the presence of a delayed coagulation time with a normal platelet count occurs hemophilia, hemorrhagic diseases of the newborn, and the hemorrhagic diathesis of obstructive jaundice. In the former there is a deficiency of thromboplastin, and in the latter two a lack of prothrombin. The administration of vitamin K is of distinct value when a definite lack of prothrombin has been established. In each of these conditions the appropriate type of medical treatment is vitally necessary to our control of the bleeding.[5]

There are, of course, many other phases of therapy which are equally important in the treatment of a case of hemorrhage. The management of the depletion resulting, and the necessary supportive measures to be followed during the convalescence could be elaborated upon at considerable length. However, in every case of hemorrhage the primary consideration is to arrest the bleeding by whatever method may be most effective in the hands of the operator. This paper has endeavored to point out in a general manner some of the more common methods in use.

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AN INSTITUTIONAL STUDY OF ACUTE APPENDICITIS OVER A 23 YEAR PERIOD

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DURING the 23 year period from 1923 through 1945, 5624 cases of acute appendicitis were treated at the Anderson County Hospital, Anderson, S. C. This is a community hospital and all the doctors of the County Medical Society are on the visiting staff. The operations were done by 15 different surgeons but the large majority were done by 8 surgeons. For the past 15 years we have been making occasional serial studies of acute appendicitis at our hospital, and repeatedly these studies have been presented at staff meetings. This paper is based on these data[1] together with a further study of cases treated during the period 1940 to 1945, inclusive. From our experiences we believe we have facts to support the following opinions.

During this period there has been a progressive decrease in the mortality of acute appendicitis. This decrease in mortality has been due in part to the leaven of education, both local and national. So well known are the symptoms of acute appendicitis that it is quite common for the family to make a tentative diagnosis before the doctor arrives. And so many people know that delay in calling for medical advice may result in a ruptured appendix that the incidence of this serious type of appendicitis has been markedly reduced. In the first decade of the period covered by this study 24 per cent of all cases of acute appendicitis were ruptured when admitted. During the last 6 years of the period only 5.3 per cent were found to be ruptured.

But not all the credit for a decreasing mortality is due to the patients. The family doctors have become more uniformly impressed with the importance of advising prompt surgical treatment in cases of acute appendicitis. And the surgical treatment has definitely improved during the period of our study. In our institution the following factors contribute to this improved surgical treatment:

The uniform use of McBurney's incision. What we are wont to call the side-door approach afforded by the McBurney incision is a

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Read before the fifteenth annual Postgraduate Surgical Assembly of The Southeastern Surgical Congress, Louisville, Kentucky, March 10-12, 1947.

very important factor in our opinion. We not only use this approach and thereby stay away from all unsoiled abdominal viscera but we are in the habit of protecting the incision itself in the following way: When the incision is made through skin, fascia and muscle and the usual skin towels are in place, before the peritoneum is opened, the finger is swept around extraperitoneally to mobilize the peritoneum. It is then possible to lift out of the wound a rather liberal tent of peritoneum. Before this is opened a folded moist square is tucked snugly into the depths of the wound on each side hugging the peritoneum closely. The latter is then opened and at the end of the incision and on each side the margins of the peritoneum are fastened to these moist squares by towel clips. This marsupializing of the peritoneum, we believe, contributes greatly to preventing wound infections. The suction tip is in readiness and any soiling encountered is carefully irrigated and aspirated. If the incision has to be enlarged on account of the position of the appendix the same careful technic is carried out to protect the wound from contact with the infected appendix. Unless a definite abscess is encountered with free purulent drainage we do not expect infection in the operative wound.

During the past 5 years we have used sulfonamides intraperitoneally in cases of ruptured appendix. Cases in which the peritonitis has been local have, we believe, been benefited by this procedure. We admit we have no very convincing data on which to base this opinion. We have no parallel series in which the sulfonamides were not used. But since we began the use of sulfonamides intraperitoneally our mortality has been lower than it ever was before. However, during this same period there has been a more uniform adoption of postoperative measures which we are confident have contributed materially to our lowered mortality. These measures include the following procedures:

1. Withholding of food. During this period we have seen more than one case of appendicitis end fatally because the patient was given food by mouth too early.

2. Maintaining the fluid balance. In ruptured cases with local and general peritonitis saline and glucose solutions are given parenterally several times a day.

3. Oxygen inhalation. When there is a moderate degree of abdominal distention the administration of oxygen for 5 or 10 minutes out of each hour, we believe, is beneficial.

4. Preventing and treating hypoproteinemia by plasma and whole blood transfusions.

5. Maintaining decompression by Wagensteen technic. The last few years we have occasionally used the Miller-Abbott tube and in a few cases have been impressed with its definite value.

6. Vitamin therapy in tedious peritonitis cases. All of us are familiar with the symptoms of avitaminosis and have seen patients improve under appropriate vitamin therapy.

7. Surgical drainage of residual abscesses. In general peritonitis residual abscesses are prone to form, particularly in the pelvis. In the latter position we have found colpotomy in the female and proctotomy in the male a satisfactory way of draining pelvic abscesses.

The declining rate in appendicitis mortality, which has been experienced in our hospital, in general, corresponds with that which has been demonstrated throughout the nation as a whole. This decline, as outlined by the Statistical Bulletin of the Metropolitan Life Insurance Company[2] shows that the mortality rate in 1940 was 9.9 per cent per 100,000 whereas in 1943 it was 6.1 per cent per 100,000. The death toll for appendicitis was 18,000 one decade ago. In 1943 the toll was 8,100 despite an increase in population. The current death rate would amount to 20,000 per year if the rate of the early 30's prevailed today.

The vast majority of opinion today has attributed the successful management of appendicitis to: (1) success of public educational programs, (2) judicious use of chemotherapy, aided by (3) antibiotics, (4) comparative advantage of spinal anesthesia over general anesthesia to facilitate the operator's range of dissection, (5) favorable results obtained without drainage, (6) wider acceptance of the McBurney incision as the incision of choice and (7) acceptance and awareness of the physiologic need for bowel rest and parenteral fluid administration during the postoperative period, as opposed to the early administration of fluids and nutrition by mouth.

In contrast to the above observations which have been advanced by Green et al[3] in their survey of appendicitis in Cleveland, by Ochsner and Johnson,[4] New Orleans, by Newell[5] of Chattanooga and others, Bower[6] and his group in Pennsylvania, during a survey of acute appendicitis for 1942, record a mortality rate of 25.96 per cent in 1937 for appendicitis with peritonitis, as opposed to a rate of 41.17 per cent in the same type of cases in 1942. They point out that the one major variable for the two periods contrasted was the use of sulfonamides in the latter period.

Likewise they deplore the failure to use drains and cite a much

ACUTE APPENDICITIS—ANDERSON COUNTY HOSPITAL

Years	Total Cases	Unruptured	Deaths	Mortality Percentage Unruptured	Ruptured	Percentage Ruptured	Deaths	Mortality Percentage Ruptured	Total Mortality Percentage
1923-1932	1287	971	17	1.8	316	24.	42	13.	4.5
1933-1934	447	375	3	.8	72	16.	7	9.09	2.21
1923-1939	3611	3011	27	0.9	600	16.3	83	13.8	3.04
1935-1939	1877	1665	7	.42	212	11.3	34	11.3	2.2
1940	388	369	1	.27	19	5.	3	15.78	1.03
1941	328	306	2	.65	22	7.	1	4.54	.9
1942	297	290	1	.35	7	2.3	2	28.5	2.3
1943	369	358	1	.28	11	3.	2	18.	1.08
1944	280	258	1	.4	22	7.8	4	18.18	1.71
1945	351	325	1	.3	26	7.4	0	.0	.28
1940-1945	2013	1906	7	.36	107	5.3	12	11.2	.94

higher mortality rate for those cases submitted to spinal anesthesia.

The above survey is convincing in its thoroughness and completeness but cannot be accepted as a general trend when compared with the statistics already quoted by the Metropolitan Life Insurance Company. Some of the disastrous results obtained with the use of sulfa drugs were due to pure folly on the part of some men who poured the powder into the peritoneal cavity without thought for the size of the patient, the condition of the peritoneum, or the toxicity of even small doses in certain cases. Also the fallacy of covering incompetent surgery with any drug or chemotherapy has been demonstrated to us all since the advent of these newer drugs and the observation of Bower's paper may be another example.

Despite a meticulous effort to include all possible factors in our analysis of appendiceal mortality there remains an X factor, which involves personalities of the surgeon and the patient, which must caution us against setting any rigid, hard and fast rules for any institution or any man. In a small series of cases reported by Dr. E. Dunbar Newell he cites 48 consecutive cases of gangrenous suppurative appendicitis in which no drainage was used, without a single death. Bower, on the other hand, cites a mortality of 64 per cent for those cases not drained, as against a mortality of 34 per cent where drainage has been used.

In conclusion, we wish to add the statistics, as gathered from the records of the Anderson County Hospital, as further evidence of the declining rate of appendicitis mortality which has been reduced for the nation as a whole.

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MASSIVE RESECTION OF SMALL INTESTINE DUE TO MULTIPLE GANGRENOUS AREAS

Case Report

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HAMMOND[1] reviews the literature of massive resection of the small bowel and gives an analysis of 257 collected cases. This study is illustrated by tables showing the incidence of age, sex, condition requiring resection, the amount of bowel removed, etc.

Later, papers dealing with the subject of massive resection of the bowel have been presented by Bowen,[2] Coleman,[4] and Pate.[5] All of these authors agree that the condition is an acute emergency and as a life saving measure desperate and heroic chances must be taken if the patient is to be given a chance to survive; further, that probably only the successful cases are reported and the end results are largely determined by compensatory hypertrophy of the remaining bowel, which influences food metabolism. There seems to be clinical laboratory evidence[3] to substantiate the opinion that these patients do well on a high carbohydrate, moderate protein, and diminished fat diet. However, there is the occasional patient who follows no dietary program, and, notwithstanding the magnitude of the bowel loss, experiences no discomfort or diarrhea.

The anatomic consideration of the intestinal tract is interesting in that different estimates vary as to the normal length of the small bowel. This discrepancy may be congenital or influenced by food habits, while some other authorities think that the stature of an individual influences the bowel length and is a fairly accurate criterion to follow.[6] In massive resection of the small intestine this may well account for the recovery of one patient while in another with a moderate resection there is a metabolic disturbance with an occasional fatal termination. It seems reasonable to suppose that patients, with a much reduced length of small bowel prior to resection, have developed compensatory changes in the bowel; consequently it is easier for this type of individual to adjust himself following resection.

From the Wilkinson Surgical Clinic.

Case Report

Miss J. W., white, age 19, was admitted to the Chesapeake and Ohio Hospital Dec. 30, 1944, with the following history: On Thursday, December 18, she had experienced cramping pains in the lower abdomen which became more aggravated. That afternoon she was seen by a physician who prescribed magnesium sulphate, which was promptly vomited. Later this dose was repeated, with the same result. The next day she was admitted to another hospital where a tentative diagnosis of kidney pathology was made. Urinalysis, however, was negative except for a slight trace of sugar. Two days after the onset the blood sugar level was slightly above normal. Vomiting continued, the patient being unable to retain anything taken by mouth. During the afternoon she was given barium by mouth and upon fluoroscopic examination a tentative diagnosis of obstruction was made. Surgery was advised.

Upon admission to the Chesapeake and Ohio Hospital the patient was desperately ill, complaining of abdominal pain, fecal vomiting. Upon examination we found her abdomen distended and rigid. Respiration was increased and labored; pulse 150, weak and thready. Since this was a surgical emergency no attempt was made to carry out laboratory tests.

Under spinal novocaine anesthetic the abdomen was opened through a right, midline incision. A quantity of bloody fluid with foul colon odor was removed by suction. The small bowel was dark, gangrenous, and the loops were adherent, due to the recent inflammatory changes. The large mass was delivered and upon inspection we found the ileum two inches from the cecum to be normal in appearance. Thinking this was a mesenteric thrombosis involving a branch of the mesenteric artery, we did a rapid resection of this mass with end-to-end anastomosis. Just as this anastomosis was completed, we noticed another gangrenous mass of intestine higher in the abdomen. Notwithstanding the desperate condition of the patient we elected to resect this mass also. The time element was so important that no thought was given as to the amount of bowel resected or the amount remaining. Upon the completion of the second resection an enterostomy was done, the rubber catheter being introduced into the intestine about 12 inches above the second anastomosis. The abdomen was washed with saline and suction. Sulfanilamide powder was sprinkled over the anastomosed area and the abdomen closed around the enterostomy tube without drainage.

During the operation this patient was given saline and plasma, and immediately following operation whole blood was administered.

The patient was cyanotic and practically moribund when the operation was begun but, strange as it may seem, her condition was little changed after one hour and ten minutes on the operating table. Due to the desperate condition of the patient our combined activity was directed toward keeping her alive. Consequently, no thought was given to the disposition of the resected bowel. Much to our disappointment and chagrin when we returned to the operating room, we found that one of the nurses had decided, inasmuch as the bowel was gangrenous and quite odoriferous, to dispose of it immediately. At that time neither of us felt the two masses resected would measure anywhere near 18 feet.

The following morning her laboratory report showed a leukocyte count of 10,450, neutrophiles (segmented) 89 per cent, lymphocytes 11 per cent,

Fig. 2. Six hour film—intestine almost empty.

Fig. 1. Gastrointestinal tract made 3 months after operation.

monocytes 1 per cent, hemoglobin 67 per cent. Urinalysis: 2 plus albumin; 2 plus sugar; 3 plus acetone, 20 to 25 pus cells. Blood sugar 134 mg. Chlorides 440 mg. Total proteins 5.2 mg. per cent.

The postoperative treatment consisted of opiates; two whole blood transfusions of 500 c.c. each given daily, with continuous hypoclysis of normal saline 2500 c.c. every 24 hours.

Her recovery was in doubt for the first three days, but from this time on the improvement was phenomenal. She began to ask for food, especially beefsteak. On the seventh day the wound was healed except for slight drainage around the enterostomy tube. This discharge became steadily more excessive and irritating, indicating that our enterostomy was in the upper segment of the jejunum. Her temperature increased and the patient's condition gave us considerable concern. At this time the blood chlorides had suddenly dropped to 280 mg. and the total blood proteins 5.9 mg. per cent. It was decided that due to the high location of the enterostomy opening and to the fact that food taken by mouth was almost instantly discharged through this opening, another operation was necessary.

On Jan. 13, 1945, or fourteen days after admission, the fistulous tract was excised by making a fairly wide elliptical incision. Upon further inspection we noted that two thirds of the bowel circumference had been destroyed by the digestive fluid. Rather than attempt to close this opening in the bowel it was deemed advisable to resect and do an end-to-end anastomosis with the healthy bowel, which required 30 minutes. The wound was closed without drainage. Upon removing the saline sheets, much to our surprise and consternation, we discovered that the last anastomosis was within eight inches of the ligament of Trietz and further that only 4 feet of the small bowel remained in which two other anastomoses had been done at the previous operation. At this point we admitted defeat and informed the family that the limited area of small bowel remaining would not permit absorption of food sufficient to maintain life.

However, in keeping with the old adage that "where there is life there is hope" we continued with the usual postoperative care, maintaining fluid balance by transfusions of glucose and saline. Her postoperative convalescence was rapid and without incident except for a demand for more food. At no time was there evidence of diarrhea or digestive disturbance. Due to the wide excoriation of the abdominal skin the last incision did not heal promptly and required care for several weeks. It is interesting to note that this patient, although eating frequently, did not immediately gain weight. However, after a few weeks the gain was phenomenal.

Today, after 22 months, this young lady is the picture of health without untoward symptoms unless perhaps she overindulges in the quantity of food taken.

There are several pathologic processes which may cause extensive gangrene of the small intestine. Hernia, obstruction by a postinflammatory or congenital adhesion band, volvulus, and, more uncommonly, extensive tuberculosis and malignancy.

As there was no such pathology found at operation the pathogenesis of the gangrene in this case must be obstruction in the

superior mesenteric vessels due to embolism or thrombosis, causing hemorrhagic infarction of the viscus with subsequent necrosis.

Embolism in the branches of the superior mesenteric artery is secondary to endocarditis, other cardiac diseases with thrombi in the left heart, or arteriosclerosis of the aorta. These pathologic conditions could be ruled out in this patient.

Primary thrombosis of the branches of the superior mesenteric vein causing gangrene of the small intestine may occur in severe septic processes involving the intestinal tract or the liver. In the latter condition the thrombus is formed in the portal vein with continuation into the superior mesenteric vein. In our case, suppurative processes within the abdominal cavity were not present. Thus, embolism and primary venous thrombosis cannot be considered.

The other possibility is a primary thrombosis in the branches of the superior mesenteric artery and the majority of the rare cases of thrombosis in the mesenteric artery with gangrene of the intestine are due to arteriosclerosis of the vessel. However, it is very unlikely that a young girl showing no signs of arteriosclerosis elsewhere should have sclerotic abdominal vessels.

A disease of the arteries leading to inflammation of the vessel wall with thrombosis is periarteritis nodosa. Although periarteritis nodosa is usually a systemic disease involving blood vessels in many regions of the body, several types have been described where the lesions are limited to one organ or organ system. One of these is the intestinal type, the disease involving only the abdominal arteries.[7,8] A few cases of intestinal periarteritis nodosa have been reported which were complicated by multiple gangrenous areas of the small intestine. Their symptomatology was very similar to that of the case reported here.[9,10,11]

No histologic proof is available in our case confirming the diagnosis of isolated intestinal periarteritis nodosa.

Since other possibilities for the pathogenesis of multiple gangrenous areas of the small intestine has been excluded, it seems reasonable to assume that this is a case of intestinal periarteritis nodosa.

It might be interesting to note that in reviewing the literature the only American authorities who refer to, or have reported, a case of primary abdominal periarteritis nodosa are Spiegel[12] and McCall, Marsh, and Pennock,[13] who report gangrenous appendices resulting from this condition.

This case is reported because of:

1. The unusual amount of intestine that was removed, or rather the very small segment of jejunum that remains.
2. The importance of keeping in mind that periarteritis nodosa can be the causative factor in mesenteric thrombosis and that when operating upon patients with this condition it is well to look for multiple gangrenous areas in the intestinal tract.

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Erratum: On page 270 of the April, 1947, issue, Dr. Samuel W. Windham, of Dothan, Ala., was listed as a Fellow of the American College of Surgeons, whereas he is a member of t he Junior Candidate Group of that organization.

The Southern Surgeon

Published Monthly by
The SOUTHERN SURGEON PUBLISHING COMPANY
701 Hurt Building
ATLANTA

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Subscription in the United States, $5.00

VOLUME XIII JUNE, 1947 NUMBER 6

THE RISE OF MODERN SURGERY

SINCE we are celebrating the 100th anniversary of the origin of the American Medical Association this year, it is quite fitting that we take a glance backward over the years for the purpose of reviewing some of the progress that has been made in the art and science of surgery during that period.

A pioneer Kentucky surgeon, Brashear, successfully performed primary amputation at the hip joint soon after the beginning of the nineteenth century. That feat was not duplicated until Valentine Mott, among the most eminent of all New York surgeons, did a similar operation in 1824. The name of Samuel D. Gross, once associated with the School of Medicine in Louisville, and that of the great Ephram McDowell, as well as that of Irvin Abell, are indications of Kentucky's contribution to surgical advancement.

The evolution of modern surgery is one of the most fascinating subjects for analysis in the entire field of the history of medicine. The surgery of the distant past was distinctly mutilating surgery. It recognized the existence of disease and the necessity for the removal of the portion of the body subject to disease as an aid to nature in bringing about cure. The surgery of today is a physiologic or functional surgery. It is designed to restore the tissues of the body as nearly as possible to normal functioning.

Read before the fifteenth annual Postgraduate Surgical Assembly of The Southeastern Surgical Congress, Louisville, Ky., March 10-12, 1947.

When Ambroise Paré, the father of modern surgery, looked back on his work after he had passed 65 years of age, he could see little by which surgery would gain in the future. Toward the end of the sixteenth century he wrote: ". . . posterity will not be able to surpass us (be it said without malice or offence) save by some additions, such as are easily made to things already discovered." Even Paré could not have had the imagination or the vision to conceive that the nineteenth and twentieth centuries would add to surgery such fundamental discoveries which would revolutionize its art and its practice and change indeed its entire nature.

The surgeon of an earlier day was primarily an anatomist. He spent long hours studying the structures of the human body so that he might know when and where to cut and how to avoid the hazards that arise when the course of a blood vessel or a nerve or a duct in the human body is subjected to interference. The surgeon of an early day was little concerned with experimentation. Obviously he could not experiment because the practice of his art was hazardous. Without the benefits of anesthesia and blood transfusion and antibiotic drugs and asepsis, he could hope only to get in and out of the body with a living patient.

John Hunter, at the end of the eighteenth century, and his brother William Hunter, noted as anatomists, were probably among the first to undertake experimentation in the field of surgery with a view to studying the functions of the tissues upon which they operated. When John Hunter tied off a blood vessel, he was interested to know what the effect of deprivation of blood would be on tissues served by the artery. The surgeon with an inquiring mind—what we would call the research type—is still far too rare in a field in which technic has been exalted in many instances far above brains. Indeed, the very evolution of surgery tended toward such exaltation of technic because speed was in an earlier day more essential than any other attribute of the surgeon.

The discovery of anesthesia was to make the great difference between surgery as a technic and surgery as an art and a science. If we credit to the researches of Paré and of John Hunter the first steps in the control of hemorrhage as primary to surgical advancement, the second great epoch must be credited to Wells and Long and Morton. This was a great step indeed. This was the removal of the fear of pain. With it the surgeon gained time. Haste gave way to accuracy. The surgeon before anesthesia was the man with the utmost speed and dexterity and strength. After anesthesia, the great surgeon was the one with the best knowledge of the struc-

ture of the human body, the functions of its various organs and tissues, and the ability to move certainly—albeit slowly—toward the accomplishment of a definite objective. Before anesthesia surgeons were known for the fact that they could amputate in a few minutes or get in and out of the body with extraordinary rapidity. The coming of anesthesia and the use of modern physiologic technics in maintaining the strength of the body over long periods of time have changed entirely the character of surgery.

As a result of anesthesia and the ability to control hemorrhage, the surgeon was able to invade portions of the body that had never previously been invaded. Now came opportunity for extended procedures carried out within the abdomen; now came the very beginning of surgery of the brain. For an American, it should be unnecessary to refer to the work of Halsted and Rudolph Matas and Harvey Cushing as some of those who contributed most greatly to these aspects of surgery.

Yet to come, however, were two more steps which were to have tremendous influence on surgical morbidity and mortality. I refer, of course, to asepsis and more recently the use of antibiotic therapy. The story of asepsis has been told so often that repetition is trite. Yet the contributions of Pasteur and of Lister had the most profound effect on morbidity and mortality rates, and surgeons were enabled to perform extensive operative procedures without the fear that subsequently their patients would die with the burning sepsis that is significant of the attack of the streptococcus and the other pus-forming organisms. Lister made his first announcement of the antiseptic method in 1867. Many years were required for the idea of complete asepsis to spread throughout the world. Indeed, it required the development of innumerable refinements in surgical technic to make aseptic surgery practicable. Think for a moment of the development of the surgical sterilizer, the use of the rubber glove, the preliminary cleansing of the hands, the development of the necessary accoutrements of the operating room, and realize how many different minds must have cooperated to bring us to the surgical ritual of today. We are also indebted to William W. Keen for his contribution to the advancement of aseptic surgery.

The surgery of today is, therefore, an outgrowth of contributions from all of the fundamental medical sciences—from anatomy, from physiology, from pathology, and from bacteriology and chemistry. The surgical principle that pus collected locally in the human body must be removed has not been superseded by any of the discoveries in the field of antiseptics or antibiotics. The old principle of resistance to infection which says that the extent depends on the

virulence and the number of infecting organisms is an indication that surgery for removal of overwhelming numbers of bacteria collected in pus is necessary for the most effective action of antiseptics and antibiotics.

Conspicuous among some of the modern examples of the application of physiology to surgery are such operative procedures as those done on the stomach in relation to the presence of ulcer and carcinoma, operations done on the sympathetic nervous system for the control of hypertension, operations for the removal of the gallbladder which could never have been attempted until the place of the gallbladder in human physiology was thoroughly established, the procedure of lobotomy, which is definitely related to the physiology of the brain, and many similar procedures. These are an indication of the necessity for a thorough understanding of the functioning of every portion of the human body in relation to surgical procedures.

Notable also in the advancement of American surgery has been the development of surgical organizations. When the American Medical Association was established in 1847, its first meetings were meetings of the entire body. By 1860, surgery had begun to differentiate itself as a specialty, and at that time a section on surgery was established. Later such special organizations as the American Surgical Association became associated with the Congress of American Physicians and Surgeons, and they have contributed greatly to establishing ideals in surgical practice and teaching.

Dr. Samuel D. Gross, who was the first president of the American Surgical Association, recognized the necessity for admitting to membership men who could qualify, but the tendency has been to keep the American Surgical Association limited in its membership. This inflexible policy has been perhaps fortunate because it stimulated the establishment of such groups as the Western Surgical Association, New England Surgical Association, the Southern Surgical Association and The Southeastern Surgical Congress, these representing the need for men of common interests and ideals to assemble for the interchange of opinion and for the establishment of policies and objectives. Indeed, the inflexible narrowness of the American Surgical Association was perhaps also responsible for the tremendous growth of the Clinical Congress of Surgeons, established in 1910, and the organization of the American College of Surgeons in 1913. The rise of surgery in the United States to the position it holds today—the leader of surgery as practiced throughout the world—may well be credited to the magnificent work of our surgical organizations.

Today, surgery has begun to recognize the importance of psychosomatic medicine in surgical practice. Dr. Franklin G. Ebaugh has called attention particularly to certain factors of doctor-patient relationship which are of the utmost importance in securing complete recovery following surgery. The practice of tact between surgeon and patient is vital not only for a proper mental attitude on the part of the patient, but also for a proper mental attitude of people in general toward their physicians in our country. The more the surgeon becomes the cold, unemotional analyst and technician, the more the patient is weaned away from surgery as an art and inclined to believe that the science of medicine can be practiced equally by a physician or a government. It has been established that emotional conflicts play a part in creating, complicating, or masking disease. The modern surgeon must recognize these mental aspects of surgical practice. And finally we have come to recognize in modern surgery the necessity for treating the patient preoperatively, during the operation and postoperatively as an exceedingly complicated organism. We recognize the necessity for maintaining adequate fluid balance, a suitable state of nutrition and a proper mental attitude throughout the entire surgical procedure. In the rise of modern surgery we recognize more and more the practice of surgery not only as a technic, but primarily as an art and a great humane discipline.

ELMER L. HENDERSON, M.D.

The Southern Surgeon, the second regional journal devoted to a specialty in the United States, is published by The Southern Surgeon Publishing Company, a subsidiary of The Southeastern Surgical Congress, for the advancement of surgery particularly in the South. In addition to publishing papers presented before the Postgraduate Surgical Assembly of The Southeastern Surgical Congress, it welcomes good surgical papers regardless of their geographic origin. It aspires to encourage surgeons in the Southern States, especially the younger ones, to record their own observations and original work.

Manuscripts for publication, books for review, and correspondence relating to the editorial management should be sent to Dr. B. T. Beasley, *Managing Editor,* 701 Hurt Building, Atlanta.

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The Southern Surgeon is now published monthly. Subscription price in the United States and Canada: $5.00; in other countries: $6.00, including postage. Single copies, $1.00 postpaid.

Checks may be made payable to The Southern Surgeon Publishing Co.